THE CHAMPION TEXT BOOK ON EMBALMING

Dr. E. Myers.
Prof. F. A. Sullivan. } Authors.

25¢

G.R. STEFAN

Yours truly
E. Myers

Respectfully
F. A. Sullivan

THE CHAMPION TEXT BOOK

ON

EMBALMING

A Systematic and Comprehensive Treatise on the Science and Art of Embalming; Giving the Latest, Simplest and Most Successful Methods, Including Descriptive and Morbid Anatomy, Physiology, Bacteriology, Sanitation, Disinfection, etc.

BY

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PROFUSELY ILLUSTRATED BY

Full Page Engravings, Half-tones and Colored Plates

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CHAMPION CHEMICAL CO.

PREFACE.

THE Embalmers and Funeral Directors of this country have made frequent complaints that they were unable to find, in books on embalming heretofore published, such information as they desire on numerous topics of professional inquiry, especially those which have been the subject of recent investigation or introduction.

To meet this confessed demand for a work of more modern character along this line, the preparation of the Champion Text Book on Embalming was undertaken.

The purpose of the authors has been to supply, within the compass of a single volume of moderate size, the information necessary to a full understanding of the subjects belonging properly to the science and art of embalming.

This work is intended both as a text book for the student and a complete reference book for the embalmer. To meet these ends, we have endeavored to furnish that information which our teaching and long experience in the practice of embalming have suggested to us to be the most needful to the student and practitioner. We have treated of anatomy and physiology to the extent necessary to give a good understanding of the structure and functions of the body, thus laying a sure foundation for the successful study and practice of embalming. After tracing the history of this art from ancient times down through the intervening ages, the most modern, simplest and best methods have been clearly set forth. Morbid anatomy and the treatment of special diseases, including those which give the embalmer the most trouble, are much more fully considered than in any similar work, thus adding largely to the value of the Text Book. The

best and latest information concerning sanitation, disinfection, infection and bacteriology, is also set forth in a terse and practical form; while much useful information is given on other subjects.

The very comprehensive Glossary at the conclusion of the work cannot but prove helpful to both student and practitioner; while, within the compass of the General Index, has been included every term and subject on which information is likely to be sought.

We have appropriated to our use many important facts found in the works constituting the physician's library, that have a direct bearing upon the subjects of which we treat; but, nevertheless, we have relied chiefly upon our own observations and experiences, especially in the operations and methods of treatment given.

We have made it a rule to write pointedly and briefly, without unnecessary verbiage, or circumlocution, on all subjects treated; and, where it could be done without sacrificing clearness or accuracy, have practiced careful abridgement of the text. As far as possible technical terms have been eliminated. Where it has been necessary to introduce them, they have been placed in the Glossary, with a clear, concise definition.

Our illustrations are of a preëminent character, much superior to any hitherto published in a similar work, and will add greatly to an elucidation of the text and a proper understanding of the methods taught.

We are especially indebted to the works of the following authors in the preparation of this book:

Anatomy:—GRAY; POTTER.
Physiology:—FLINT; STEELE; BALDWIN; HUXLEY.
Morbid Anatomy and Pathology:—FLINT; OSLER; STILLE; BRISTOWE; AITKEN; QUAIN; GREEN; PEPER'S SYSTEM.
Bacteriology and Sanitation:—STERNBERG; ABBOTT; SYKES.

THE AUTHORS.

SPRINGFIELD, OHIO, Jan. 1, 1897.

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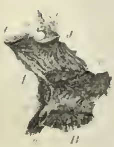

Fig. 8

PLATE I.

BONES OF HEAD.

Fig. 1.—Front View of Cranium.

A. Frontal bone.
B. Parietal bone.
C. Great wing of sphenoid bone.
D. Temporal (temple) bone.
E. Malar (cheek) bone.
F. Superior maxillary (upper jaw).
G. Nasal bone.
H. Inferior maxillary (lower jaw).

a. Coronal suture.
b. Frontal suture.
c. Squamous suture.
d. Frontal eminence.
e. Superciliary arch.
g. Zygnomatic process of malar bone.
h. Supra-orbital ridge.
i. Supra-orbital foramen.
k. Nasal process.
l. Frontal crest of temporal ridge.
m. Nasal process of superior maxillary.
n. Malar process of superior maxillary.
o. Alveolar process of superior maxillary.
p. Infra-orbital foramen.
q. Superior maxillary fossa.
r. Nasal spine of superior maxillary.
s. Anterior nasal opening.
t. Infra-orbital margin of superior maxillary.
u. Fossa of lachrymal sac.
v. Alveolar process of superior maxillary.
w. Maxillary process of malar bone.
x. Frontal process of malar bone.
y. Temporal process of malar bone.
z. Anterior malar foramen.

Fig. 2.—Side View of Cranium.

A.—H. Same as Fig. 1.

a. Frontal eminence.
b. Superciliary arch.
d. Nasal process of frontal bone.
e. Supra-orbital margin of frontal bone.
f. Supra-orbital foramen of frontal bone.
g. Malar process of frontal bone.
h. External frontal crest of temporal ridge.
i. Temporal or semicircular ridge.
k. Coronal suture.
l. Parietal eminence.
m. Squamous plate of temporal bone.
o. Mastoid process.
q. Meatus auditorius externus.
r. Zygomatic arch.
s. Temporal process of malar bone.
t. Frontal process of malar bone.
u. Maxillary process of malar bone.
v. Anterior malar foramen.
w. Malar process of superior maxillary.
x. Superior maxillary fossa.
y. Infra-orbital foramen.
z. Superior maxillary protuberance.

Fig. 3.—Vertical Section of Facial Bones.

Showing inner surface of orbit, antrum highmorianum, and lateral surface of superior maxillary, with portions of sphenoid, temporal, and palate bones posteriorly.

Fig. 4.—Vertical Section of Facial Bones.

Showing interior and outer wall of nasal cavity, with portions of frontal, ethmoidal, and sphenoidal sinuses.

Fig. 5.—Ethmoid Bone — Upper Surface.

Fig. 6.—Ethmoid Bone — Nasal Surface.

Fig 7.—Palate Bone — Nasal Surface.

Fig. 8.—Hyoid Bone — Anterior Aspect.


Fig.1
Fig.6
Fig.2
Fig.8

PLATE II.

BONES OF THE HEAD—(Continued).

Fig. 1.—Base of Skull—Inner Surface.

A. Frontal bone.
B. Lesser wings of sphenoid bone.
C. Greater wings of sphenoid bone.
D. Squamous plate of temporal bone.
E. Petrous portion of temporal bone.
F. Mastoid portion of temporal bone.
G. Occipital bone.
H. Basilar process of occipital bone.
I. Ethmoid bone.

a. Orbital plates of frontal bone.
b. Digital depressions.
c. Internal frontal spine.
d. Crista galli.
e. Foramina cribrosa.
f. Anterior clinoid processes.
g. Optic foramen.
h. Middle clinoid processes.
i. Sella turcica.
k. Posterior clinoid processes.
l. Internal carotid sulcus.
m. Foramen lacerum anterius orbitale.
n. Foramen rotundum.
o. Foramen ovale.
p. Foramen spinosum.
q. Hiatus canalis Fallopii.
r. Internal auditory canal.
t. Jugular foramen.
u. Occipital fossa.
w. Ante-condyloid foramen.
x. Posterior condyloid foramen.
y. Mastoid foramen.
z. Foramen magnum.

Fig. 2.—Inferior Surface of Cranium—Base of Skull.

A. Bony or hard palate.
B. Alveolar ridge of superior maxillary.
C. Superior maxillary.
D. Palate or horizontal plate of palate bone.
E. Pterygoid processes of sphenoid bone.
F. Greater wing of sphenoid.
G. Vomer.
H. Squamous plate of temporal bone
I. Mastoid process.
K. Petrous portion of temporal bone.
L. Basilar process.
O. Zygomatic arch.

a. Foramen incisivum.
b. Posterior nasal spine.
f. External pterygoid plate.
g. Posterior nasal openings.
h. Foramen ovale.
i. Foramen spinosum.
k. Inferior orbital fissure.
m. Condyloid eminence.
n. Fissura Glaseri.
o. Eustachian tube.
p. External auditory canal.
q. Internal carotid foramen.
r. Styloid process.
s. Stylo-mastoid foramen.
t. Aqueduct of cochlea.
u. Jugular foramen.
v. Fossula petrosa.
w. Condyles of occipital bone.
x. Anterior condyloid foramen.
y. Posterior condyloid foramen.
z. Mastoid process.

Figs. 3 and 4.—Temporal Bone—External Surface (3); Inner Surface (4).

A. Squamous plate.
B. Mastoid portion.
C. Petrous portion.

Figs. 5 and 6.—Sphenoid Bone—Inner Surface (5); Anterior Surface (6).

A. Body.
B. Lesser wings.
C. Greater wings.

Figs. 7 and 8.—Inferior Maxillary—Outer Surface (7); Inner Surface (8).

A. Body.
B. Ascending ramus.

a. Base or inferior margin.
b. Alveolar border.

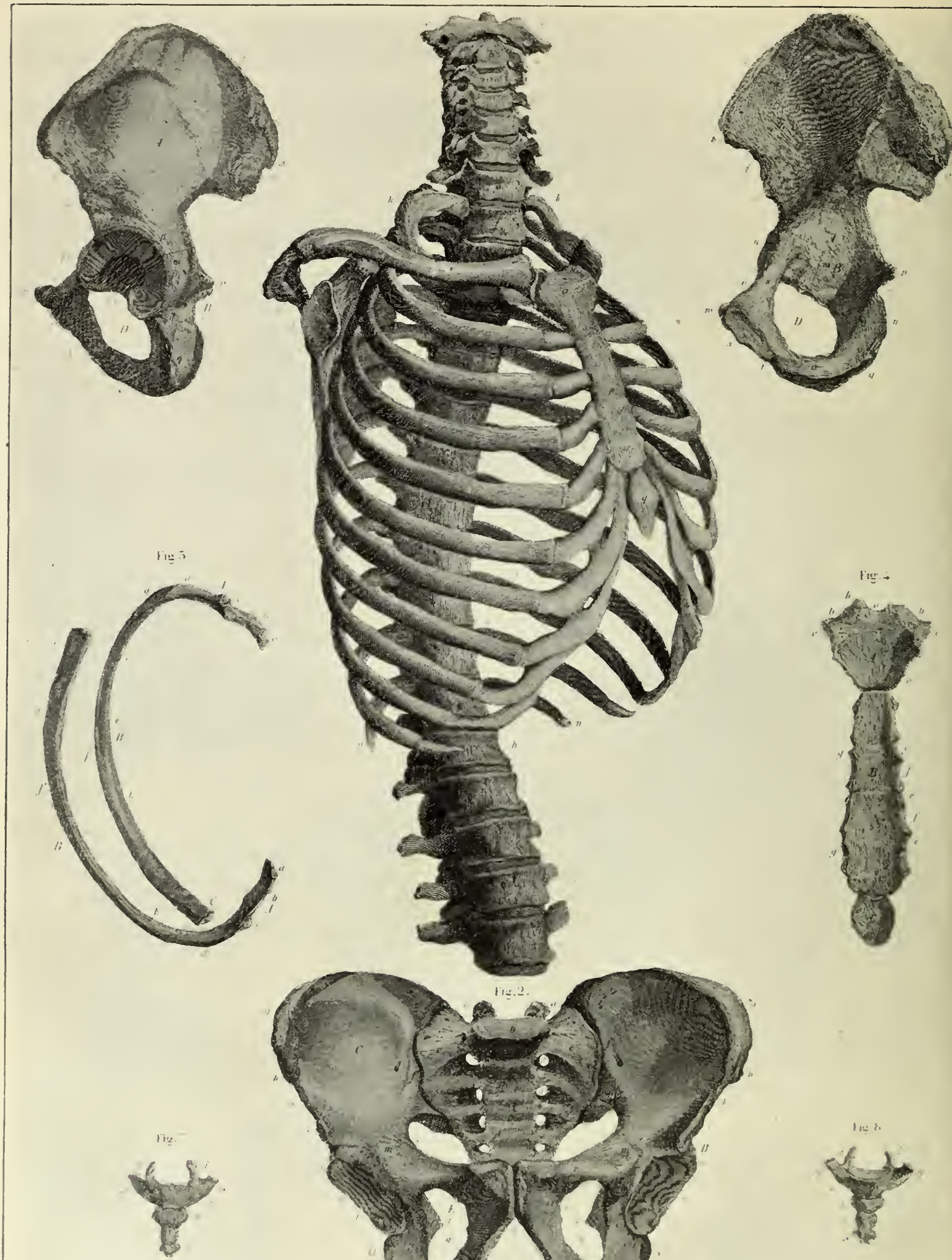
Fig.2.

PLATE III.

BONES OF TRUNK.

Fig. 1.—Spine (Vertebræ), Thorax, Clavicle, and portion of Scapula.

a. Atlas first vertebra.
b. Axis second vertebra.
c. Last cervical vertebra.
d. Vertebral canal for vertebral artery.
e. Odontoid process.
f. First dorsal vertebra.
g. Last dorsal vertebra.
h. First lumbar vertebra.
i. Last lumbar vertebra.
k. First rib.
l. Last true or sternal rib.
m. First false or asternal rib.
n. Last floating rib.
o. Manubrium or first bone of sternum.
p. Body or middle piece of sternum.
q. Ensiform or xiphoid process.
r. Clavicle.
s. Scapula.
t. Glenoid cavity of scapula.

Fig. 2.—Pelvis.

A. Sacrum.
B. Innominatum.
C. Ilium.
D. Ischium.
E. Pubes.

a. Superior oblique process of sacrum.
b. Base or promontory of sacrum.
c. Linear arcuata interna.
d. Anterior sacral foramen.
e. Inferior brim of pelvis.
f. Sacro-iliac symphysis.
g. Crest of ilium or superior brim of pelvis.
h. Anterior superior spinous process of ilium.
i. Anterior inferior spinous process of ilium.
k. Anterior semilunar notch.
l. Spine of ischium.
m. Ilio-pubal eminence.
n. Acetabulum.
o. Brim of acetabulum.
p. Notch of acetabulum.
q. Obturator foramen.
r. Horizontal branch of pubes.
s. Spine of pubes.
t. Descending ramus of pubes.
u. Symphysis pubis.
v. Ascending ramus of ischium.
w. Tuber of ischium.
x. Descending ramus of ischium.

Fig. 3.—True or Sternal Ribs.

A. Posterior extremity.
B. Body.
C. Anterior extremity.

a. Head.
b. Neck.
c. Tubercle.
d. Angle.

Fig. 4.—Sternum—Anterior Surface.

A. Manubrium, or first bone.
B. Body or middle portion.
C. Ensiform or xiphoid process.

a. Superior semilunar notch.
b. Clavicular fossa.
c. Articular fossa for first rib.
d. Articular fossa for second rib.
e. Articular fossæ for true ribs.

Fig. 5.—Os Innominatum of Right Side—Inner Surface and Lines of Articulation of Ilium, Ischium, and Pubes.

A. Ilium.
B. Ischium.
C. Pubes.
D. Obturator foramen.

Fig. 6.—Os Innominatum of Left Side—Outer Surface.

A.—D. As in Fig. 5.
E. Acetabulum.

Figs. 7 and 8.—Coccyx Bone—Posterior Surface (7); Anterior and Upper Surfaces (8).

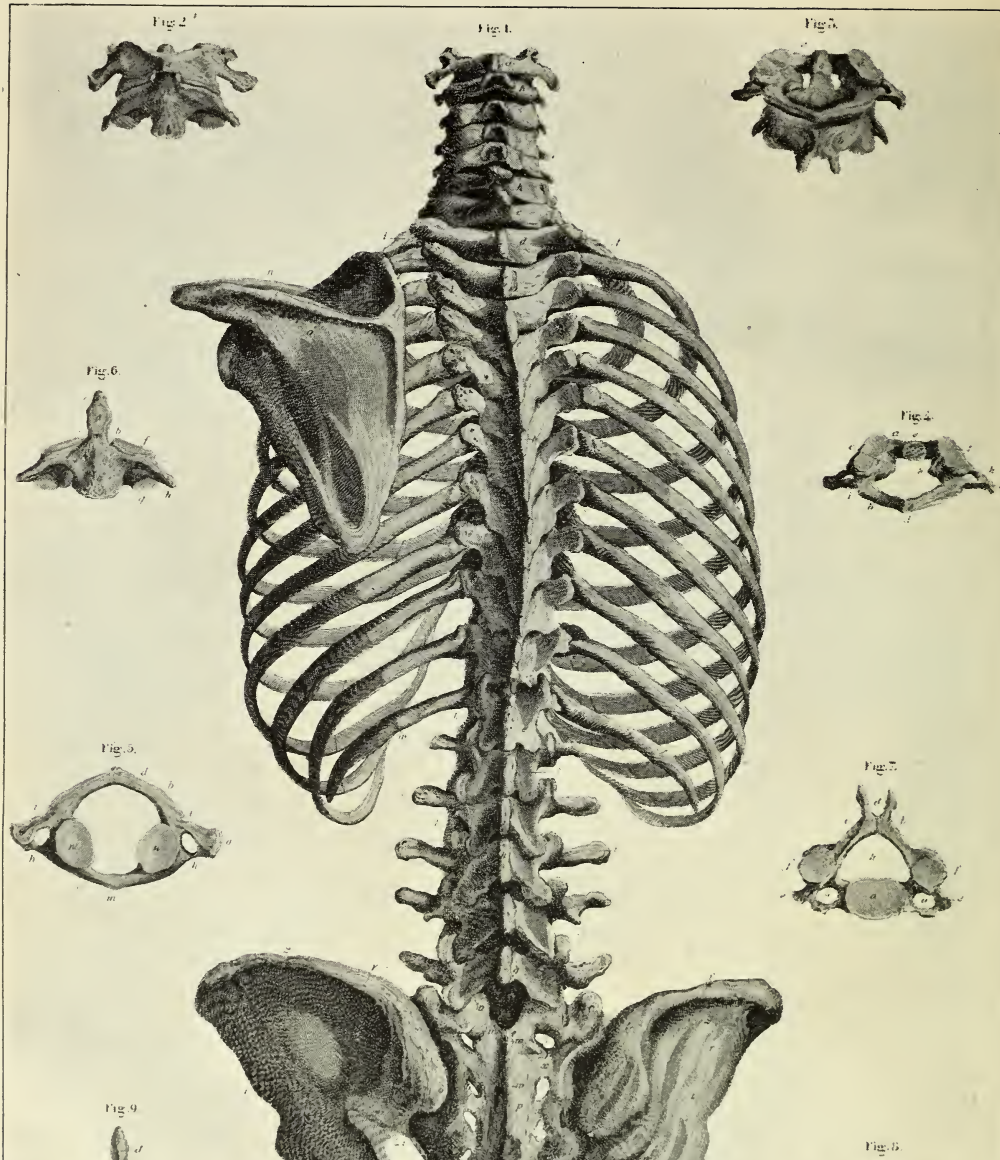
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Fig.9.

PLATE IV.

BONES OF TRUNK—(Continued).

Fig. 1.—Posterior View of Trunk.

a. Atlas. (See Figs. 2, 3, 4, and 5.)
b. Axis.
c. Last cervical vertebra.
d. First dorsal vertebra.
e. Last dorsal vertebra.
f. First lumbar vertebra.
g. Last lumbar vertebra.
h. Spinous processes.
i. Transverse processes.
k. Intervertebral foramen.
l. First rib.
m. Last rib.
n. Clavicle.
o. Scapula. (See Table V., Figs. 3, 4, and 5.)
p. Sacrum.
q. Coccyx.
r. Ilium.
s. Ischium.
t. Pubes.
u. Opening to sacral canal.
v. Superior oblique processes of sacrum.
w. False spinous processes.
x. Posterior sacral foramen.
z. Cornua of sacrum.

Figs. 2 and 3.—Atlas and Axis—Anterior Surface (2); Posterior Surface (3).

a-b. Same as Fig. 1.
c. Odontoid process.
d. Articular surface of atlas for occipital condyle.

Figs. 4 and 5.—Atlas—Superior Surface (4); Inferior Surface (5).

a. Anterior half arch.
b. Posterior half arch.
c. Lateral mass.
d. Posterior tubercle of atlas.
e. Articular surface for odontoid process.
f. Condyloid fossa.
g. Transverse process of atlas.
h. Vertebral foraman.
i. Groove for vertebral artery.
k. Internal tubercle for transverse ligament.
l. Spinal canal.
m. Anterior tubercle of atlas.
n. Inferior anticular or oblique processes.

Fig. 6.—Axis—Anterior Surface.

a. Body.
b. Odontoid process.
c. Neck of odontoid process.
d. Articular surface for anterior half arch of atlas.
e. Apex of odontoid process.
f. Superior oblique processes.
g. Inferior oblique processes.
h. Transverse processes.

Fig. 7.—Cervical Vertebra—Superior Surface.

a. Body.
b. Arch.
c. Spinous process.
d. Interspinous cleft.
e. Transverse processes.
f. Superior oblique processes.
g. Vertebral foramen.
h. Spinal canal.

Figs. 8 and 9.—A Dorsal (8); and a Lumbar Vertebra (9)—Superior Surfaces.

a. Body.
b. Arch.
c. Vertebral notch for intervertebral foramen.
d. Spinous process.
e. Transverse processes.
f. Articular surface for costal tubercle.
g. Superior oblique processes.

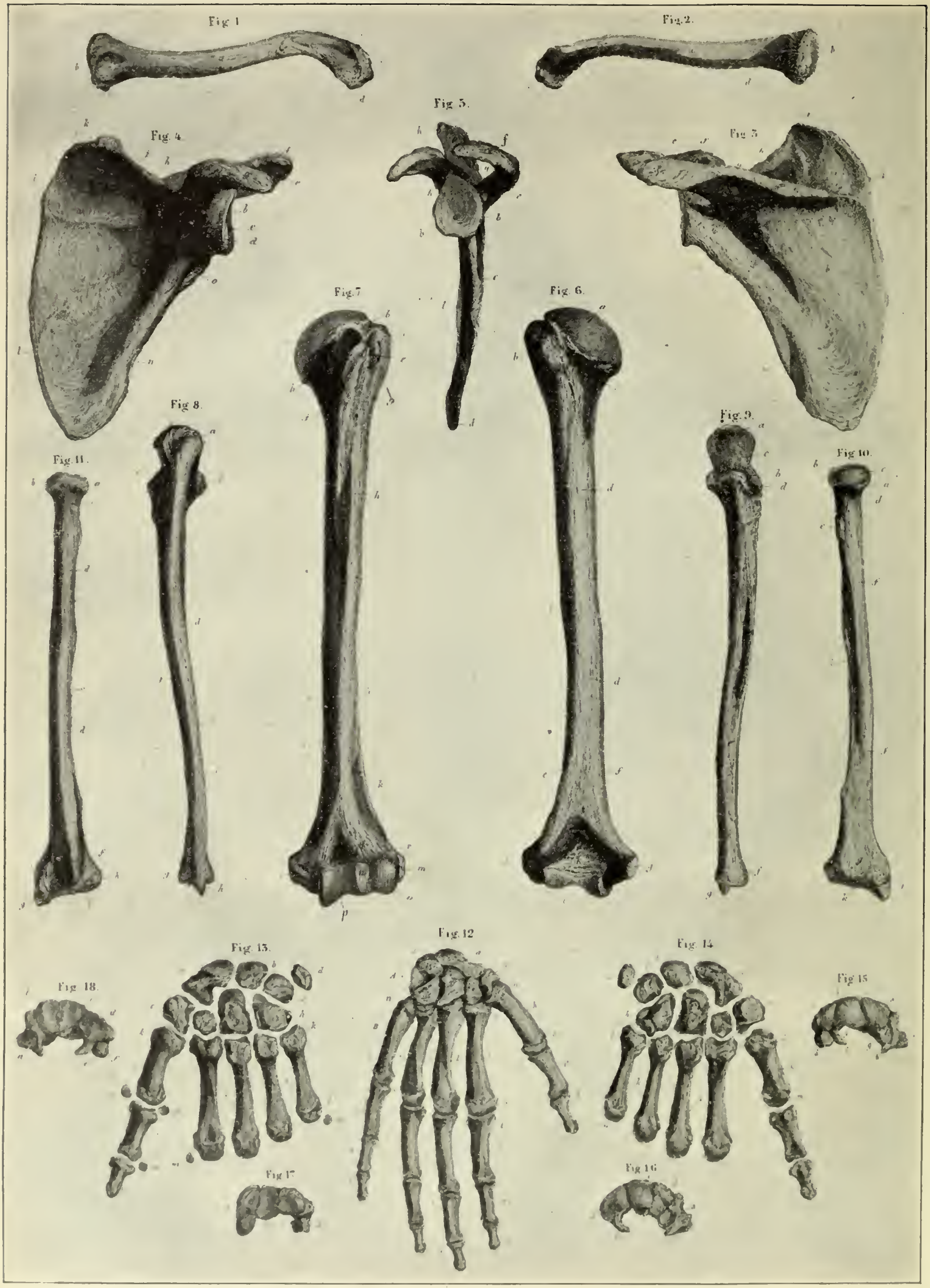
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Fig 16

PLATE V.

BONES OF UPPER EXTREMITIES.

Figs. 1 and 2.—Clavicle (Left)—Superior Surface (1); Inferior Surface (2).

a. Body.
b. c. Sternal (*b*) and Acromial (*c*) end.

Fig. 3.—Scapula—Posterior and Outer Surface.

a. Supra-spinatus fossa.
b. Infra-spinatus fossa.
c. Spine.
d. Acromion process.
e. Articular surface for clavicle.
f. Coracoid-process.
o. Neck.
p. Glenoid cavity.

Fig. 4.—Scapula—Internal, or Concave, Surface.

a. Subscapular fossa.
b. Anterior angle or condyle.
c. Glenoid cavity.
d. Margin or brim of glenoid cavity.
e. Acromion process.
h. Supra-scapular notch.
o. Tubercle for origin of triceps muscle.

Fig. 5.—Scapula—Front View of Anterior Margin.

a. Glenoid cavity.
b. Brim of cavity.
c. Anterior margin.
d. Inferior angle.
e. Spine.

Fig. 6.—Humerus (Left)—Posterior View.

a. Head of humerus.
b. Greater tuberosity.
c. Neck (anatomical).
d. Body.
e. f. External (*e*) and Internal (*f*) ridge.
g. h. Internal (*g*) and External (*h*) condyle.
i. Trochlea.

Fig. 7.—Humerus (Left)—Anterior View.

Figs. 8 and 9.—Ulna—Posterior View (8); Anterior View (9).

a. Olecranon process.
b. Coronoid process.
c. Greater sigmoid notch.

Figs. 10 and 11.—Radius—Anterior View (10); Posterior View (11).

Fig. 12.—Bones of Right Hand—Posterior Surface.

A. Carpus.
B. Metacarpus.
C. Fingers—phalanges.

a. Navicular.
b. Lunar.
c. Cuneiform.
d. Trapezium.
e. Trapezoid.
f. Magnum.
g. Unciform.
h–m. Metacarpal bones.
n. Bases of metacarpal bones.
o. Heads of metacarpal bones.
p–t. Phalanges.

Figs. 13 and 14.—Carpus, Metacarpus, and Phalanges of Thumb (Left)—Posterior Surface (13); Anterior Surface (14).

Figs. 15 and 17.—Carpal Bones (Left), First Row—Superior Articular Surface (15); Inferior Surface (17).

a. Navicular.
b. Lunar.
c. Cuneiform.
d. Pisiform.

Figs. 16 and 18.—Carpal Bones (Left), Second Row—Intercarpal Articular Surface (16); Digital Surface (18).

a. Trapezium.
b. Trapezoid.
c. Magnum.
d. Unciform.
e. Hamular process of unciform.

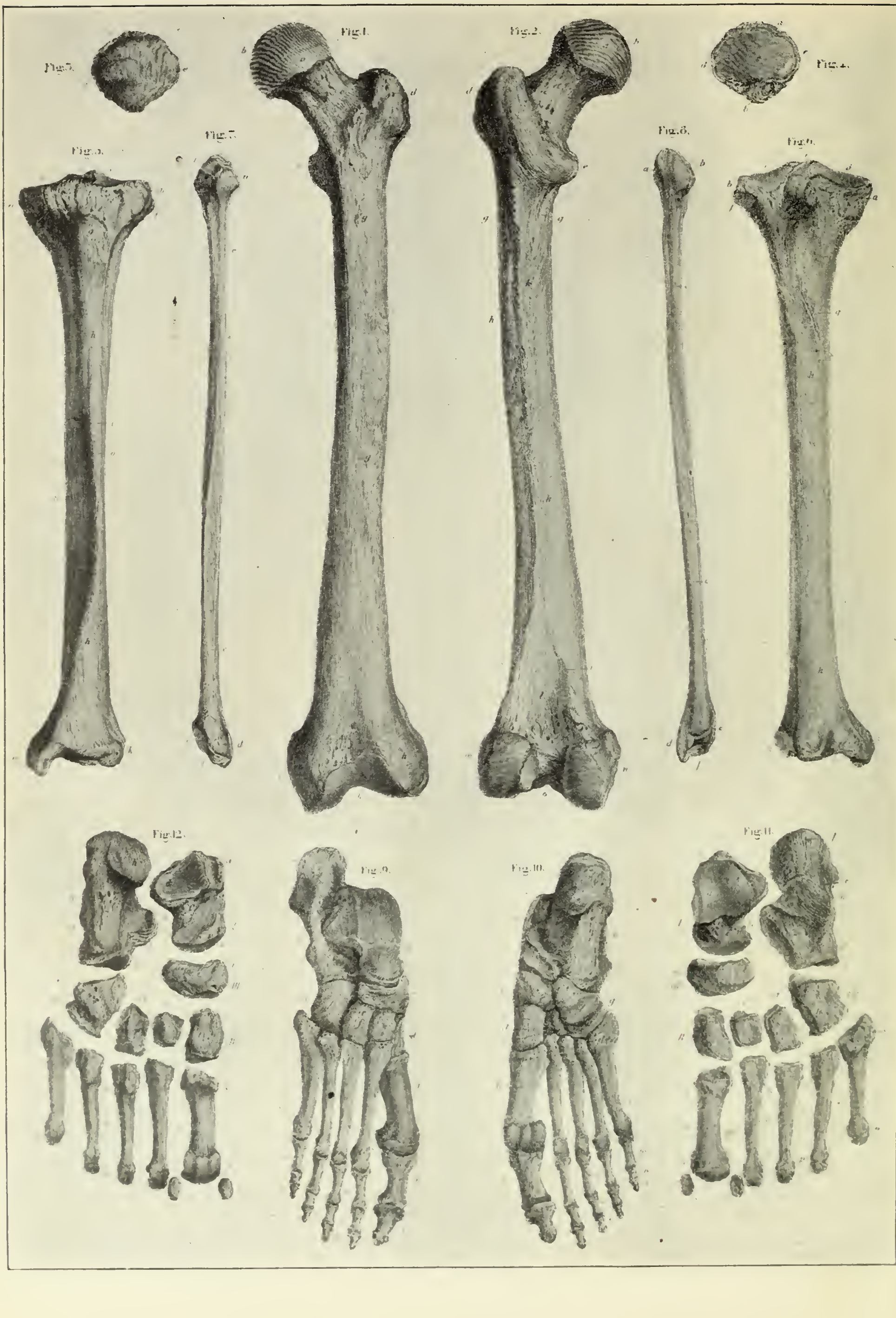
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Fig.12.

PLATE VI.

BONES OF LOWER EXTREMITIES.

Fig. 1.—Femur (Left)—Anterior Surface.

a. Head.
b. Fossa for ligamentum teres.
c. Neck.
d. Trochanter major.
e. Trochanter minor.
f. Anterior Inter-trochanteric line.
g. Body.
h. External condyle.
i. Internal condyle.
k. Articular surface for patella.

Fig. 2.—Femur (Left)—Posterior Surface.

a–e. As in Fig. 1.
f. Posterior inter-trochanteric line.
g. Superior oblique lines of linea aspera.
h. Linea aspera.
i. Inferior oblique line of linea aspera.
k. Body.
l. Popliteal fossa.
m. External condyle.
n. Internal condyle.
o. Inter-condyloid fossa.

Figs. 3 and 4.—Left Patella (Knee Cap)—Anterior Surface (3); Posterior Surface (4).

Figs. 5 and 6.—Tibia (Left) Anterior and Inner Surfaces (5); Posterior Surface (6).

a. Internal condyle.
b. External condyle.
c. Internal articular surface.
d. External articular surface.
e. Inter-condyloid eminence.
f. Articular surface for head of fibula.
l. Articular surface for astragalus.
m. (5). *i.* (6). Internal malleolus.

Figs. 7 and 8.—Fibula (Left)—Anterior Surface (7); Posterior Surface (8).

a. Capitulum or head.
b. Superior articular surface.
c. Body.
d. External malleolus.
e. Tibial surface.
f. Articular surface of astragalus.

Figs. 9 and 10.—Bones of Foot (Right)—Upper or Dorsal Surface (9); Inferior or Plantar Surface (10).

a. Astragalus.
b. Os calcis.
c. Navicular.
d, e, f. Cuneiform bones.
g. Cuboid.
h, i. Metatarsal bones.
k, m. First phalanges.
l, n. Second phalanges.
o. Third or ungual phalanges.

Figs. 11 and 12.—Tarsal and Metatarsal Bones (Left)—Upper or Dorsal Surface (11); Under or Plantar Surface (12).

I. Astragalus.
II. Os calcis.
III. Navicular.
IV. Internal cuneiform bone.
V. Middle cuneiform bone.
VI. External cuneiform bone.
VII. Cuboid.

n. Metatarsal bones.
o. Bases.
p. Heads.
q. Tuberosity of fifth metatarsal bone.
r. Sesamoid bones of great toe.

Tab. VII

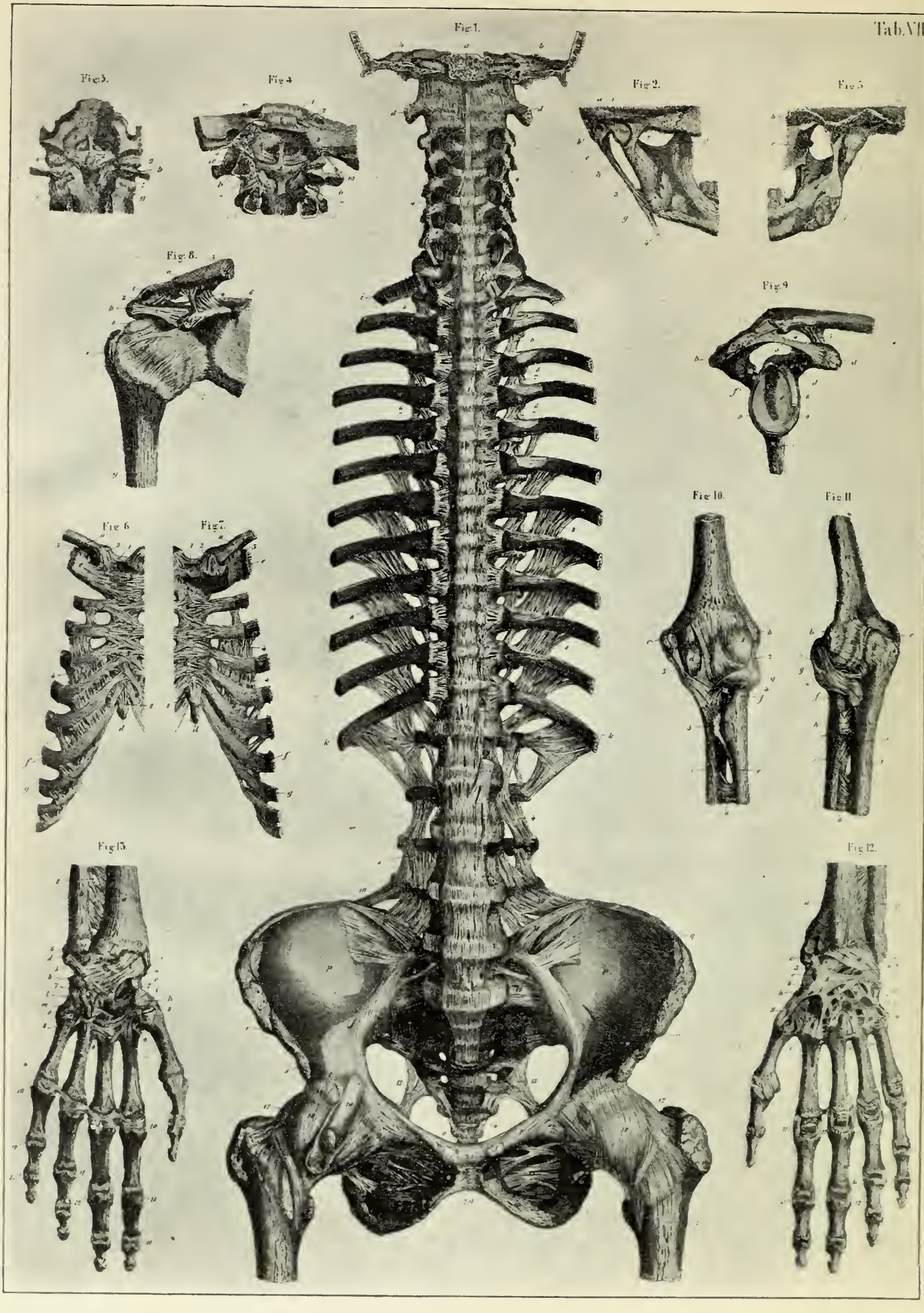

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Fig. 13.

PLATE VII.

LIGAMENTS OF HEAD, TRUNK, AND UPPER EXTREMITIES.

Fig. 1.—Ligaments of the Vertebræ, Sternal End of Ribs, Pelvis, and Ilio-Femoral Articulation—Anterior Surface.

1. Anterior vertebral ligament.
2. Anterior occipito-atlantoid ligament.
3. Intervertebral fibro-cartilage.
4. Intertransverse ligaments.
5. Posterior costo-vertebral ligaments.
6. Internal costo-transverse ligaments.
7. External costo-transverse ligaments.
8. Posterior intercostal ligaments.
9. Lumbo-costal ligaments.

Figs. 2 and 3.—Ligaments of Right Temporo-Maxillary Articulation—External Surface (2); Internal Surface (3).

1. Capsular ligament.

Figs. 4. and 5.—Internal Ligaments Connecting Occipital Bone with Axis and of the Articulation between Atlas and Axis—Posterior View, the Posterior Half Arches of these Bones having been removed.

Figs. 6 and 7.—Ligaments of Sterno-Clavicular and Sterno-Costal Articulations with Anterior Intercostal Ligaments—Anterior Surface (6); Posterior Surface (7).

1. Interclavicular ligament.
2. Internal capsular ligament of sterno-clavicular articulation.
3. Rhomboid ligament.

4, 4. Ligamenta coruscantia.
5. Anterior proper sternal ligament.
6. Posterior proper sternal ligament.

Figs. 8 and 9.—Ligaments of Shoulder-Joint and Scapulo-Clavicular Articulation.

1. Claviculo-acrominal ligament.
2. External capsular ligament of clavicle.
3. Trapezoid ligament.
4. Conoid ligament.
5. Coraco-acrominal ligament.
6. Transverse ligament of scapula.
7. Capsular ligament of shoulder-joint.
8. Tendon of long head of biceps.
9. Glenoid ligament.

Figs. 10 and 11.—Ligaments of Left Elbow-Joint—Anterior Left Surface (10); Posterior Surface (11).

1. Capsular ligament.
2. External lateral ligament.
3. Internal lateral ligament.
4. Orbicular ligament of radius.
5. Oblique ligament of radio-ulnar articulation.
6. Interosseous ligament.

Fig. 12.—Ligaments of Left Wrist-Joint and Hand.

1. Interosseous ligament.

2, 3. Same as Figs. 10 and 11.

4. Posterior radio-carpal ligament.
5. Posterior superficial carpal ligaments.
6. Posterior deep carpal ligaments.
7. Internal lateral ligament of carpus.
8. Proper ligaments of carpus.
9. Dorsal carpo-metacarpal ligaments.

10, 10. Dorsal ligaments of metacarpal bases.

11, 11. External lateral ligaments of fingers.

12. Internal lateral ligaments of fingers.

Fig. 13.—Ligaments of Left Wrist-Joint and Hand—Anterior Surface.

2, 3. Anterior radio-carpal ligaments.

4. Lateral radial ligaments.
5. Lateral ulnar ligament.
6. Triangular cartilage.

7, 7. Anterior proper carpal ligaments.

8, 8. Anterior carpo-metacarpal ligaments.

9, 9. Anterior inter-metacarpal ligaments.

10, 11, 12. Ligaments of metacarpo-phalangeal articulation.

Fig. 1.

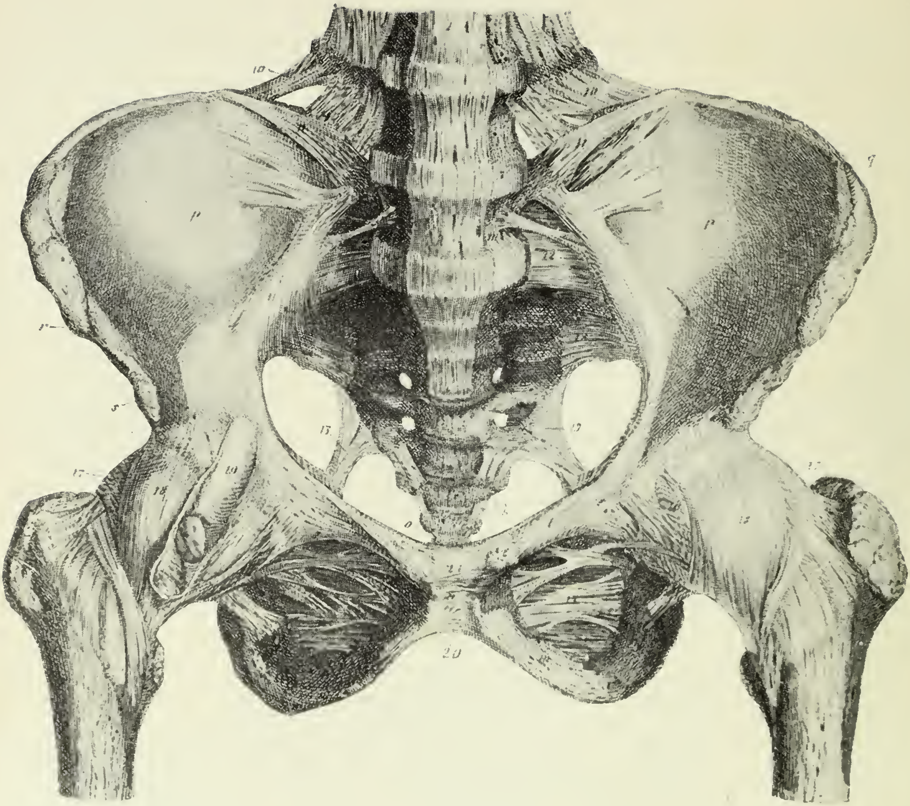


PLATE VIII.

LIGAMENTS OF PELVIS AND ADJOINING ARTICULATIONS.

Fig. I.—Ligaments of Lower Part of Spine, Pelvis, and Ilio-femoral Articulations.

m. Last lumbar vertebra.
n. Sacrum.
o. Coccyx.
p. Ilium.
q. Crest of ilium.
r. Anterior superior spine of ilium.
s. Anterior inferior spine of ilium.
t. Horizontal ramus of pubes.
u. Descending ramus of pubes.
v. Symphysis pubis.
w. Ascending ramus of ischium.
x. Tuber of ischium.
y. Descending ramus of ischium.

(For Bones of Pelvis see Plate III.)

10. Superior ilio-lumbar ligaments.
11. Inferior ilio-lumbar ligaments.
12. Anterior ilio-sacral ligaments.
13. Lesser sciatic ligaments.
14. Anterior sacro-coccygeal ligament.
15. Obturator ligaments.
16, 17. Capsular ligament of hip.
18. Accessory ligaments of hip.
19. Bursa of internal iliac muscle.
20. Sub-pubic ligament.
21. Inter-pubic ligament.

Tab. VII.

Fig. 5.

Fig. 1.

Fig. 3.

Fig. 2.

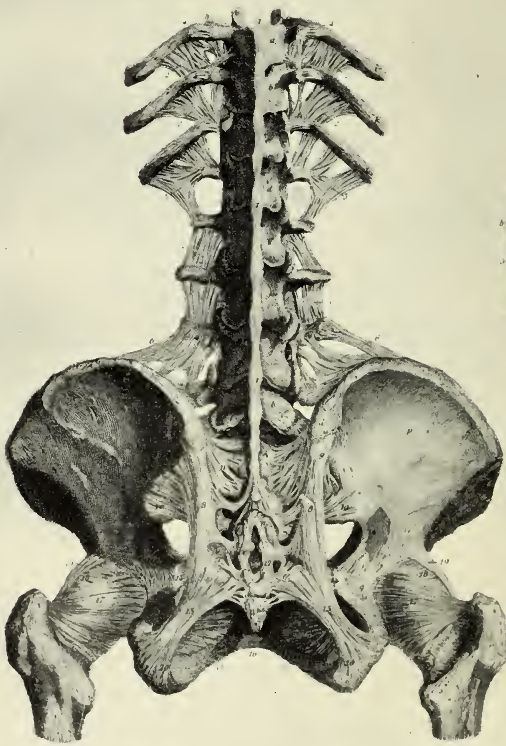
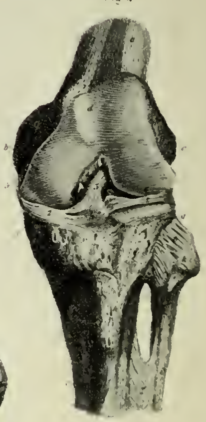


Fig. 6.

Fig. 4.



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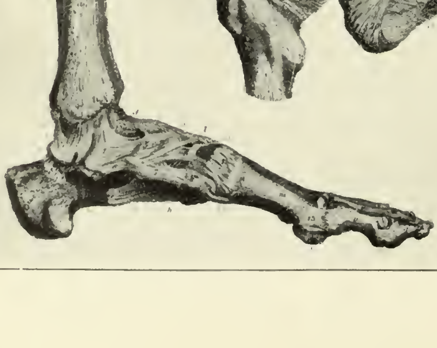

Fig. 8.

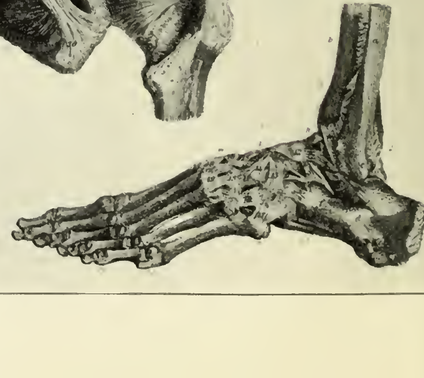

PLATE IX.

LIGAMENTS OF SPINE, PELVIS, AND JOINTS OF LOWER EXTREMITIES.

Fig. 1.—Ligaments of Cervical and Dorsal Vertebræ.

1. Superior attachment of posterior ligament.
2. Apparatus ligamentosus colli (neck).
3. Capsular ligament.
5. Posterior costo-transverse ligament.
6. Ligaments of necks of ribs.

Fig. 2.—Dorsal Ligaments of Spinal Column, Pelvis, and Ilio-Femoral Articulations.

(For bones of pelvis see Plate IV.)

1. Inter-spinous ligaments.
2. Posterior intercostal ligaments.
3. Lumbo-costal ligaments.
4, 5. Transverse ligaments.
6, 7. Ilio-lumbar ligaments.
8, 9, 10. Ilio-sacral ligaments.
11. Posterior irregular ligaments.
12. Posterior sacro-coccygeal ligaments.
13, 14. Sacro-sciatic ligaments.
15. Obturator ligament.
16. Sub-pubic ligament.
17, 18, 19. Capsular ligament.

Fig. 3.—Ligaments of Left Knee-joint.

1. Ligament of patella.
3. Internal lateral ligament.
4. Capsular ligament.

Figs. 4 and 5.—Ligaments of Left Knee-joint—Internal Anterior View (4); Posterior View (5).

1, 2. Semilunar cartilages.
3, 4. Crucial ligaments.
6. Capsular ligament of head of fibula.
7. Interosseous membrane of leg.

Fig. 6.—Ligaments of Sole of Left Foot.

1. Astragalo-calcanean ligaments.
2. Calcaneo-cuboid ligament.
3. Calcaneo-navicular ligament.
4. Cuboideo-navicular ligament.
5, 6, 7. Cuneiform ligaments.
8, 11. Cuboideo-metatarsal ligaments.
9, 10, 12. Metatarsal ligaments.
13. Fibro-cartilaginous sheaths for flexor tendons.
14, 15. Lateral ligaments of phalanges.
16. Crucial ligaments.
17. Inter-sesamoid ligaments.

Fig. 7.—Ligaments of Left Foot—Internal Surface.

1. Internal lateral or deltoid ligament.
2. Posterior ligament of ankle.
3. Posterior astragalo-calcanean ligament.
4. Plantar calcaneo-cuboid ligament.
5, 6. Navicular ligaments.
7, 8, 9. Naviculo-cuneiform ligaments.
10. Dorsal inter-cuneiform ligament.
11. Dorsal ligament of base of first metatarsal bone.
12. Plantar ligament.
13. Internal lateral ligaments of toes.

Fig. 8.—Ligaments of Left Foot—External and Dorsal Surfaces.

1. Interosseous membrane of leg.
2. Posterior tibio-fibular ligaments.
3, 4. Anterior tibio-fibular ligaments.
5, 6, 7. Lateral ligaments of ankle.
8. Tarsal apparatus ligamentosus.
9, 10. Calcaneo-cuboid ligaments.
11, 12, 13. Dorsal navicular ligaments.
14, 15. Dorsal naviculo-cuneiform ligaments.
16. Dorsal inter-cuneiform ligaments.
17, 18, 19. Dorsal ligaments of tarsus and metatarsus.
20. External lateral ligaments of toes.

Tab

Fig 1.

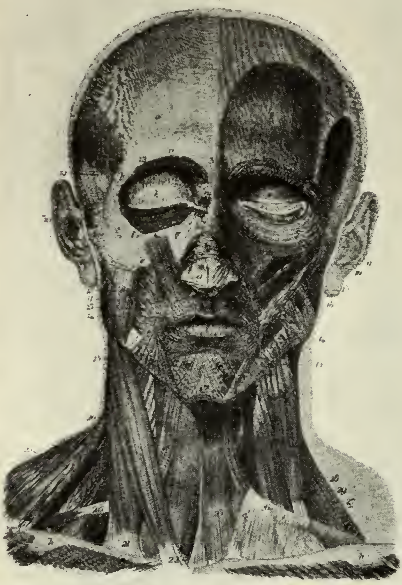

Fig 2

Fig 4

Fig. 5.

PLATE X.

MUSCLES OF HEAD AND NECK.

Fig. 1.—Muscles of Face and Neck—Anterior Surfaces.

1, 2. Occipito-frontal.
3. Pyramidalis nasi.
4, 5. Orbicularis palpebrarum.
6. Corrugator supercilii.
7. Levator labii superioris alæque nasi.
8. Levator labii superioris proprius.
9, 10. Minor and major zygomatic.
11. Levator anguli oris.
12. Levator palpebræ superioris tendon.
13. Buccinator; (14) Orbicularis oris.
15. Triangularis menti.
16. Quadratus menti.
17. Levator menti.
18. Masseter; (19) Temporal.
20, 21, 22. Sterno-cleido-mastoid.
23. Sterno-hyoid; (24) Sterno-thyroid.
25. Anterior margin of trapezius.
26. Omo-hyoid.
27. Levator anguli scapulæ.
28, 29. Scalenus anticus et medius.
30. Attrahens auris.
31. Compressor naris.

Fig. 2.—Muscles of Neck—Right Side.

1, 2. Digastric.
3. Hyo-digastric membrane.
4. Mylo-hyoideus.
5. Hyo-glossus.
6. Stylo-hyoid; (8) Stylo-glossus.
9. Stylo-pharyngeus.
10. Middle constrictor of pharynx.
11. Inferior constrictor of pharynx.
12. Thyro-hyoid membrane.
13. Thyro-hyoid.
14. Sterno-hyoid; (15) Sterno-thyroid.
16, 17, 18. Omo-hyoid.
19. Longus colli.
20. Rectus capitis anticus major.
21, 22. Three scaleni.
23. Levator anguli scapulæ.
24. Splenius capitis.
25. Sterno-cleido-mastoideus.
26. Obliquus capitis superior.
27. Obliquus capitis inferior.
28. Trapezius.
29. Deltoid.

Fig. 5.—Muscles of Neck—Front View.

1–6. Same as Fig. 2.
7. Stylo-glossus.
8. Stylo-pharyngeus.
9. Genio-hyoideus.
10. Thyro-hyoideus.
11. Sterno-thyroid.
12. Inferior constrictor of pharynx.
13. Sterno-hyoid.
14, 15. Omo-hyoid.
16. Crico-thyroideus.
17. Longus colli.
18, 19, 20. Three scaleni.
21. Levator anguli scapulæ.
22. Splenius capitis.

Fig. 4.—Deep Muscles of Right Side of Neck.

1. Orbicularis oris.
2. Buccinator.
3. Superior constrictor of pharynx.
4. Stylo-glossus.
5. Stylo-pharyngeus.
6. Middle constrictor of pharynx.
7. Hyo-glossus.
8. Mylo-hyoid.
9. Thyro-hyoid.
10. Inferior constrictor of pharynx.
11. Thyro-hyoid membrane.
12. Crico-thyroid muscle.
13. Rectus capitis anticus major.
14, 15, 16. Three scaleni.
17. Levator anguli scapulæ.
18. Splenius capitis.
19. Serratus posticus superior.
20. Superior rhomboid.
21. Trapezius.
22. Supraspinatus.
23. Sterno-thyroid.

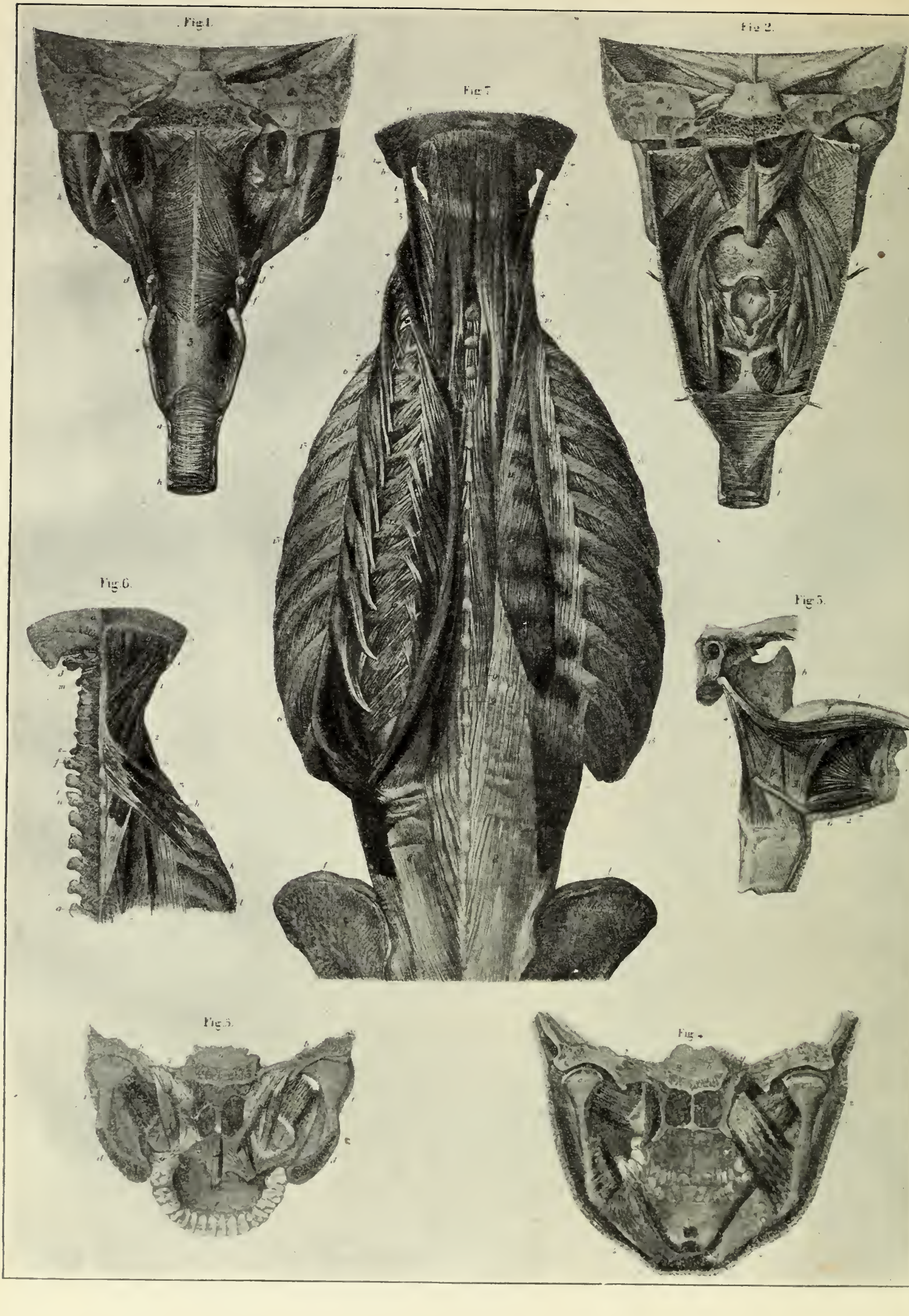

Fig.1.
Fig 2.
Fig 7.
Fig 6.
Fig 5.
Fig 3.
Fig 4.

PLATE XI.

MUSCLES OF POSTERIOR PART OF NECK, TRUNK, PHARYNX, PALATE, LOWER JAW AND TONGUE.

Fig. 1.—Muscles of Back of Pharynx and Lower Jaw.

a. Basilar process.
b. Petrous bone.
c. Ramus of lower jaw.
d. Posterior cornua of hyoid.
e. Thyroid cartilage.
f. Thyro-hyoid ligament.
g. Esophagus; (*h*) Trachea.
i. Styloid process.
k. Stylo-maxillary ligament.

1, 2, 3. Constrictors of pharynx.
4. Stylo-pharyngeus.
5. Stylo-glossus; (6) Mylo-hyoid.
7. Internal pterygoid.
8. Masseter; (9) Buccinator.

Fig. 2.—Muscles of Palate and Throat—Posterior View.

a, b, c. Same as Fig. 1.
d. Styloid process.
e. Posterior nostrils.
f. Condyle of lower jaw.
g. Base of tongue; (*h*) Epiglottis.
i. Cricoid cartilage.
k. Esophagus; (*l*) Trachea.

1, 2, 3. Same as Fig. 1.
4. Azygos uvulæ.
5. Levator palati mollis.
6. Circumflexus palati mollis.
7. Crico-arytænoideus posticus.
8. Palato-pharyngeus.

Fig. 3.—Muscles of Tongue—Lateral View of Right Side.

a. Body of lower jaw.
b. Ramus of lower jaw.
c. Styloid process.
d. Hyoid bone; (*e*) Larynx; (*f*) Tongue.

1. Lingualis; (2) Genio-glossus.
3. Hyoglossus; (4) Stylo-glossus.
5. Stylo-pharyngeus.
6. Genio-hyoideus.
7. Mylo-hyoideus.
8. Thyro-hyoid membrane.

Fig. 4.—Internal Muscles of Lower Jaw.

a. Body of sphenoid bone.
b. Petrous bone.
c, d, e. Lower jaw.
f. Hard palate.
g. Pterygoid process.
h. Posterior nostrils.

1. Pterygoideus internus.
2. Pterygoideus externus.
3. Masseter; (4) Mylo-hyoideus (divided).
5. Genio-glossus (divided).
6. Genio-hyoideus (divided).

Fig. 5.—Muscles of Soft Palate.

e. Hard palate.
f. Pterygoid process.
g. Hamular process.
h. Posterior nostrils.
i. Eustachian tube.

1. Pterygoideus externus.
2. Levator palati mollis.
3. Circumflexus palati mollis.
4. Azygos uvulæ.
5. Palati-pharyngeus.

Fig. 6.—Muscles of Posterior Surface of Neck and Upper Part of Thorax.

a. Occipital bone.
b. Superior semilunar line.
c. Mastoid process.
m. Ligamentum nuchæ.
n. Ligamentum apicum.

1. Splenius capitis.
2. Splenius colli.
3. Serratus posticus superior.
4. Biventer cervicis.
5. Complexus cervicis.
6. Transversalis cervicis.
7. Longissimus dorsi.

Fig. 7.—Deep Muscles of Neck and Back.

1. Biventer cervicis.
2. Complexus cervicis.
3. Trachelo-mastoideus.
4. Transversalis cervicis.
5. Cervicalis ascendens.
6. Lumbo-costalis.
7. Longissimus dorsi.
8. Sacro-lumbalis.
9. Spinalis dorsi.
10. Spinalis cervicis.
11. Semispinalis dorsi.
12. Levatores costarum.
13. Intercostales.
14. Obliquus capitis superior,

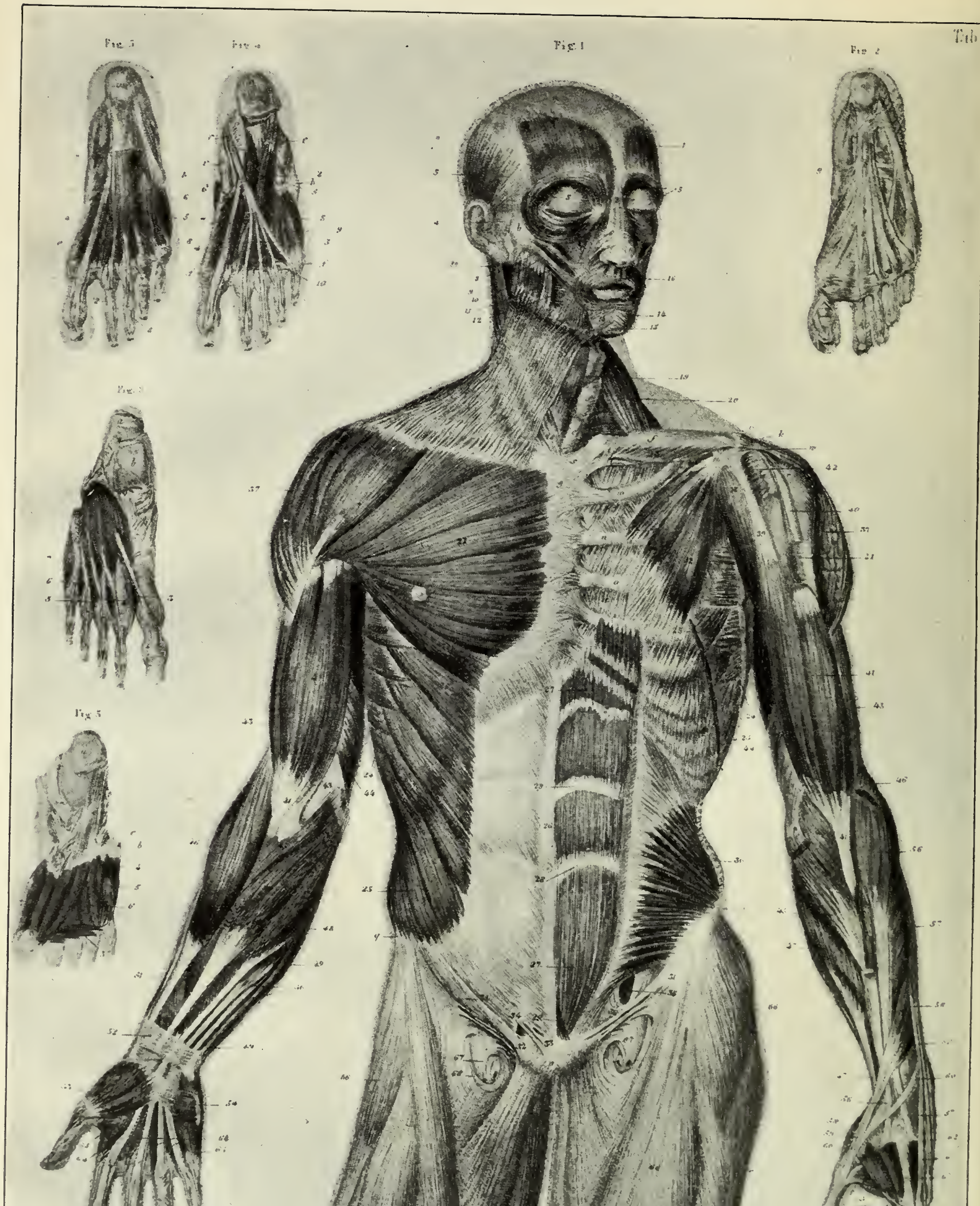
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Fig. 4
Fig. 5
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PLATE XII.

MUSCLES OF THE TRUNK, ARMS, AND FEET.

Fig. 1.—Muscles of Face, Trunk, Arms, and Upper Part of Thighs—Anterior View.

a. Occipito-frontalis tendon.
d. Thyroid gland.
g. Manubrium of sternum.
i. Carocoid process; (*k*) Acromion.
p. Symphysis pubis.
q. Anterior superior spine of ilium.
s. Interclavicular ligament.
t. Rhomboid ligament.
u. Ligamenta coruscantia.
v. Claviculo-acromial ligament.
w. Coraco-acromial ligament.

1. Frontalis.
2. Pyramidalis nasi.
3, 4. Attollens et attrahens auris.
5. Orbicularis palpebrarum.
6. Levator labii superioris alæque nasi with compressor nasi.
7. Levator labii superioris proprius.
8, 9. Minor and major zygomatic.
10. Levator anguli oris.
11. Masseter; (12) Buccinator.
13, 14. Triangularis et quadratus menti.
15. Levator menti.
16. Orbicularis oris.
17. Platysma-myoides or latissimus colli.
18. Sterno-cleido-mastoid.
19. Sterno-hyoid.
20. Scaleni.
21, 22. Pectoralis major et minor.
23. Subclavian.
24. Serratus magnus anticus.
25. External oblique (abdominis).
26. Linea alba.
27. Rectus abdominis.
28. Transverse aponeuroses of rectus abdominis.
29. Pyramidalis abdominis.
30. Obliquus internus.
31. Poupart's ligament.
32, 33. Pillars of Poupart's ligament.
34, 35. Abdominal rings.
36. Inguinal canal.
37. Deltoid.
38. Coraco-brachialis.
39, 40. Short and long head of biceps.
41. Biceps.
42. Subscapular; (43) Brachial.
44. Internal head of triceps.
45. Pronator teres.
46. Supinator longus.
47. Flexor carpi radialis.
48. Palmaris longus.
49. Flexor carpi ulnaris.
50. Flexores of fingers.
51. Long flexor of thumb.
52. Anterior annular ligament of carpus.
53. Abductor of thumb.
54. Palmaris brevis.
55. Adductor of thumb.
56. Extensor carpi radialis longus.
57. Extensor carpi radialis brevis.
58. Extensor ossis metacarpi pollicis.
59. Extensor primi internodii pollicis.
60. Extensor secundi internodii pollicis.
61. Extensor indicis.
62. Extensor digitorum communis.
63. Abductor indicis.
64. Lumbricales.
65. Abductor of little finger.
66. Fascia lata femoris.
67. External femoral ring.
68. Falciforn process of fascia lata.

Fig. 2.—Plantar Fascia or Aponeurosis of Right Foot.

Fig. 3.—Plantar Muscles, First Layer—Inferior Surface, Right Foot.

Fig. 4.—Second Layer of Plantar Muscles of Right Foot.

Fig. 5.—Third Layer of Plantar Muscles of Right Foot.

Fig. 6.—Fourth Layer of Dorsal Muscles of Right Foot.

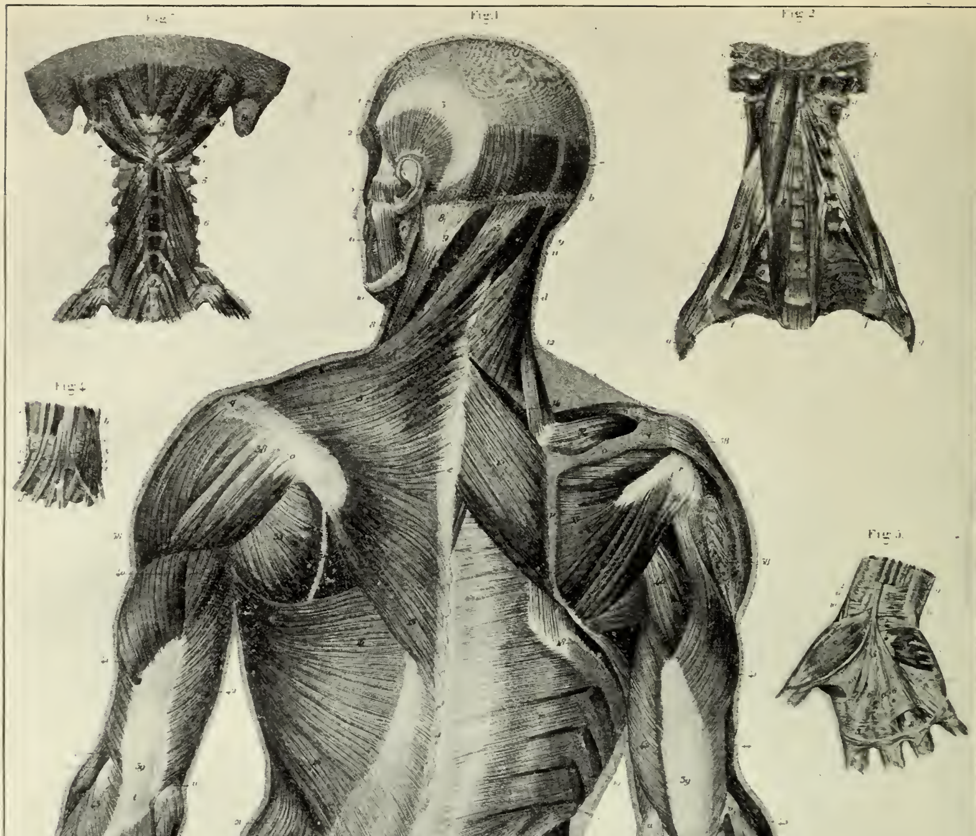
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Fig 2
Fig 4
Fig 5.

PLATE XIII.

MUSCLES OF TRUNK, NECK, AND ARMS.

(Posterior View, with some of Anterior Surface.)

Fig. 1.—Muscles of Trunk, Upper Part of Thighs, and Arms.

1. Frontalis.
2. Ocbicularis palpebrarum.
3. Attollens auris.
4. Retrahentes auris.
5. Attrahens auris.
6. Masseter; (7) Occipitales.
8. Sterno-cleido-mastoideus.
9. Splenius capitis.
10. Splenius colli.
11. Complexus cervicis.
12. Levator anguli scapulæ.
13. Trapezius.
14, 15. Rhomboideus minor et major.
16. Latissimus dorsi.
17. Serratus posticus inferior.
18. Serratus anticus major.
19. External intercostal.
20. Sacro-lumbalis.
21. Obliquus abdominis externus.
22. Obliquus abdominis internus.
23. Glutæus maximus (divided).
24. Glutæus medius.
25. Pyriformis.
26, 28. Gemellus superior et inferior.
27, 30. Obturator internus et externus
29. Quadratus femoris.
31. Vastus externus.
32. Semimembranosus.
33. Adductor magnus.
34. Supraspinatus.
35. Infraspinatus.
36, 37. Teres minor et major.
38. Deltoideus.
39. Triceps brachialis.
40. Long head of triceps.
41. External head of triceps.
42. Internal head of triceps.
43. Anconæus.
44. Brachialis internus.
45. Supinator longus.
46. Extensor digitorum communis.
47. Extensor carpi ulnaris.
48. Extensores carpi radiales.
49. Extensor pollicis brevis.
50. Abductor pollicis longus.
51. Extensor pollicis longus.
52. Flexor digitorum communis.

Fig. 2.—Deep Muscles of Neck—Anterior View.

1. Longus colli.
2. Rectus capitis anticus major.
3. Rectus capitis anticus minor.
4. Rectus capitis lateralis.
5, 6, 7. Three scaleni.
8. Intertransversarii.

Fig. 3.—Deep Muscles of Back of Neck.

a. Occipital bone.
b. Mastoid process.
c. Posterior tubercle of atlas.

1. Rectus capitis posticus minor.
2. Rectus capitis posticus major.
3. Obliquus capitis superior.
4. Obliquus capitis inferior.
5. Interspinales.
6. Multifidus spinæ (cervicis).

Fig. 4.—Tendons and Tendinous Sheaths on Posterior Surface of Carpus.

Fig. 5.—Tendons and Tendinous Aponeuroses of Right Wrist and Hand.

a. Radius; (*b*) Pisiform bone.
c. Muscular mass of thumb.
d. Muscular mass of little finger.

1, 2. Palmaris brevis et longus.
3. Anterior annular ligament of carpus.
4. Anterior proper carpal ligament.
5. Palmar fascia or aponeurosis.
6. Terminations of palmar aponeurosis.
7. Transverse palmar ligaments.
8. Sheaths of long flexor tendons.
9. Flexor carpi ulnaris tendon.
10. Flexor carpi radialis tendon.

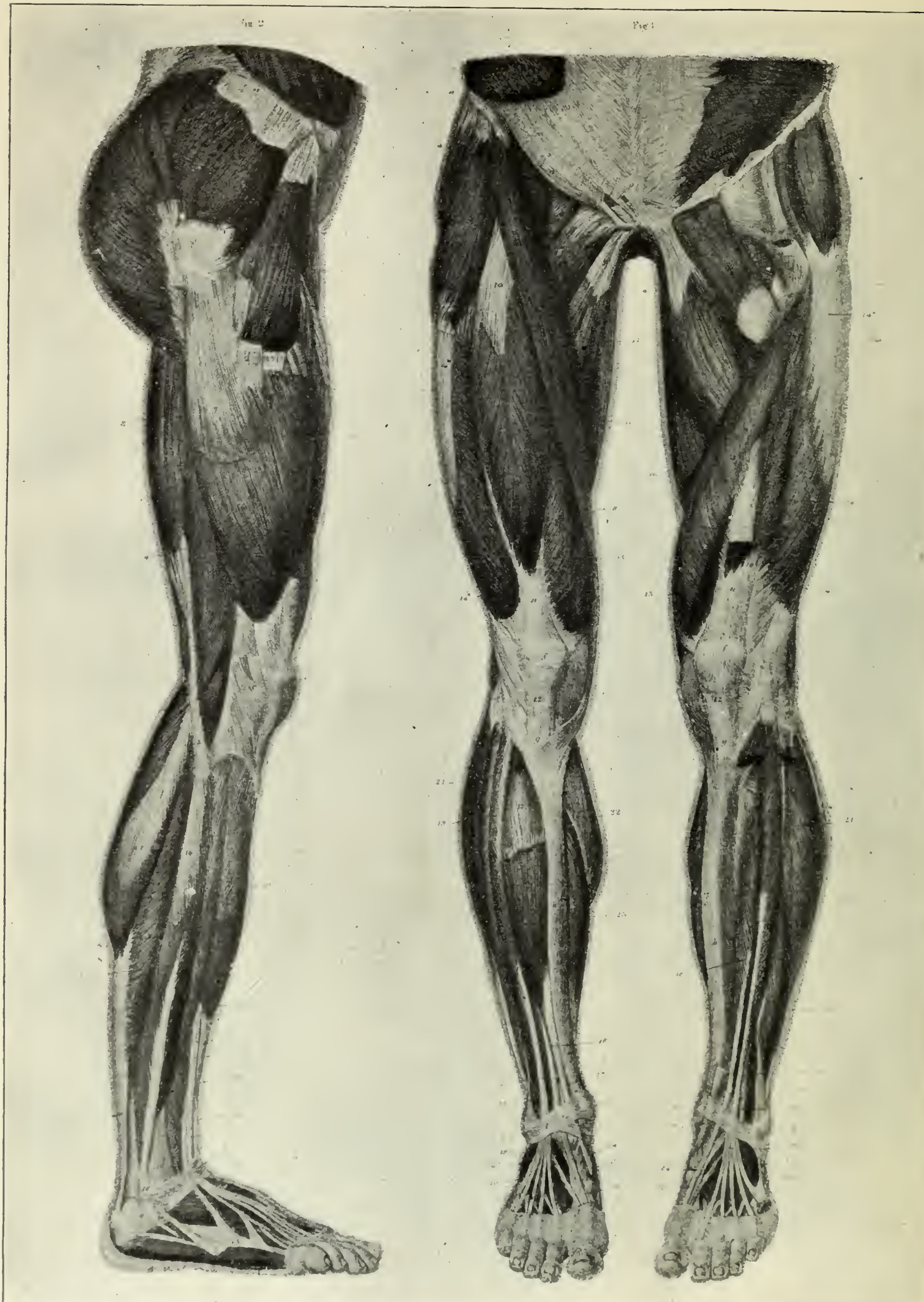


PLATE XIV.

MUSCLES OF THE ANTERIOR AND EXTERNAL SURFACES OF PELVIS AND LOWER EXTREMITIES.

Fig. 1.—Muscles of Anterior Surface of Lower Extremities.

a. Crest of ilium.
b. Anterior superior spinous process.
c. Trochanter major.
d. Symphysis pubis.
e. Trochanter minor.
f. Patella.
g. Tuberosity of tibia.
h. Tibia.
i. Malleolus internus.
k. Malleolus externus.
l. Anterior annular ligament of ankle-joint.
m. Fibula.
n. Linea alba.
o. Poupart's ligament.
p. Internal pillar of external abdominal ring.
q. External pillar of external abdominal ring.
r. External abdominal ring.
s. Internal abdominal ring.
t. Posterior boundary of inguinal canal.

1. Obliquus abdominis externus.
2. Transversalis abdominis.
3. Tensor fasciæ latæ.
4. Glutæus medius.
5. Iliacus internus.
6. Psoas major.
7. Pectinæus; (8) Sartorius.
9. Adductor longus.
10. Rectus femoris.
11. Tendo communis extensorius.
12. Ligament of patella.
13. Vastus internus.
14. Vastus externus.
14.* Tendinous portion of vastus externus.
15. Gracilis.
16. Adductor magnus.
17. Tibialis anticus.
18. Extensor longus pollicis pedis.
19. Extensor digitorum communis longus.
20. Peronæus tertius.
21. Peronæus longus brevis.
22. Gastrocnemius; (23) Soleus.
24. Extensor brevis pollicis pedis.
25. Extensor digitorum communis brevis.

Fig. 2.—Muscles on External Surface of Right Side of Pelvis and Lower Extremity.

a. Crest of ilium.
b. Anterior superior spine of ilium.
c. External condyles of knee-joint.
d. Tibia.
e. Patella.
f. Anterior annular ligament of ankle.
g. External portion of annular ligament.
h. Tuberosity of fifth metatarsal bone.

1. Tensor fasciæ latæ.
2. Fascia lata.
3. Glutæus medius.
4. Glutæus maximus.
5. Sartorius.
6. Rectus femoris.
7. Vastus externus.
8. Biceps femoris (caput longum).
9. Caput breve bicipitis femoris.
10. Tibialis anticus.
11. Extensor digitorum communis longus.
12. Extensor longus pollicis pedis.
13. Peronæus tertius.
14. Peronæus longus.
15. Peronæus brevis.
16. Sheaths of long and short peronæal tendons.
17. Soleus.
18. Gastrocnemius.
19. Tendon of Achillis.
20. Extensor digitorum communis brevis.
21. Abductor digiti minimi.

Fig. 1.

Fig. 2.

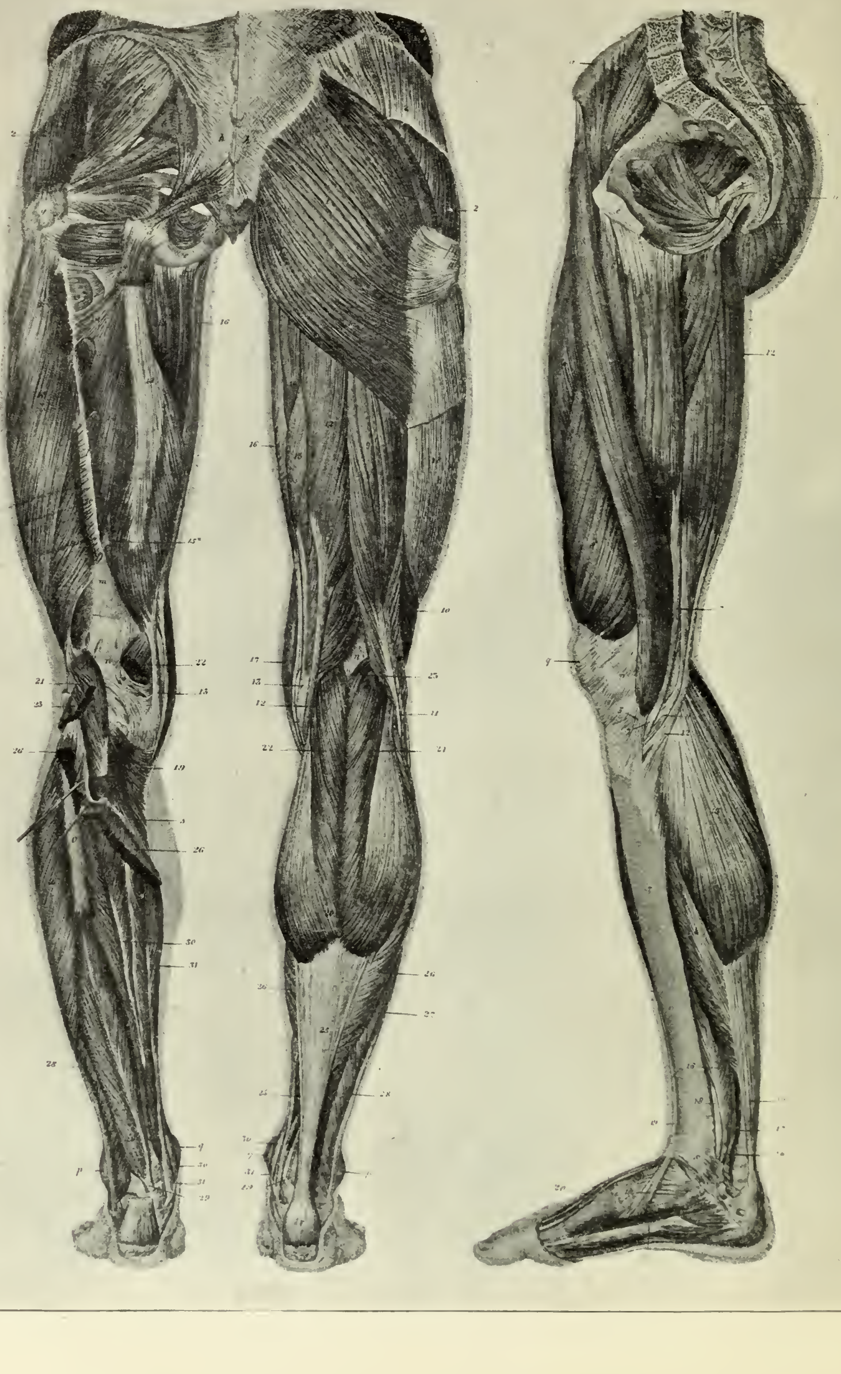


PLATE XV.

MUSCLES OF THE POSTERIOR AND INNER SURFACES OF PELVIS AND LOWER EXTREMITIES.

Fig. 1.—Muscles of Posterior Surface of Pelvis and Lower Extremities.

a. Crest of ilium.
b. Ilium.
c. Coccyx.
d. Tuber of ischium.
e. Ascending ramus of ischium.
f. Descending ramus of pubes.
g. Trochanter major.
h. Sacrum.
i. Lesser sacro-sciatic ligament.
k. Greater sacro-sciatic ligament.
l. Linea aspera.
m. Femoral.
n. Popliteal fossa.
o. Fibula.
p. Malleolus externus.
q. Malleolus internus.
r. Tendon of Achillis.
s. Oblique line of tibia.

1. Glutæus maximus.
2. Glutæus medius.
3. Pyriformis.
4. Gemellus superior.
5. Obturator internus.
6. Gemellus inferior.
7. Quadratus femoris.
8. Obturator externus.
9. Caput longum bicipitis femoris.
10. Caput breve bicipitis femoris.
11. Tendo bicipitis femoris.
12. Semitendinosus.
13. Semimembranosus.
14. Adductor magnus.
15. Openings in adductor magnus for branches of perforating artery and profunda femoris vein.
15.* Inferior opening of Hunter's canal.
16. Gracilis.
17. Sartorius.
18. Vastus externus.
19. Poplitæus.
20. Gastrocnemius.
21. External head of gastrocnemius.
22. Internal head of gastrocnemius.
23. Plantaris.
24. Plantar tendon.
25. Tendon of Achillis.
26. Soleus.
27. Peronæus longus.
28. Peronæus brevis.
29. Flexor pollicis pedis longus.
30. Tibialis posticus.
31. Flexor communis digitorum pedis longus.

Fig. 2.—Muscles of Inner Surface of Pelvis, Thigh, Leg, and Foot.

a. Crest of ilium.
b. Sacrum.
c. Coccyx.
d. Linea innominata interna.
e. Symphysis pubis.
f. Obturator foramen.
g. Great sacro-sciatic ligament.
h. Lesser sacro-sciatic ligament.
i. Great sciatic notch.
k. Lesser sciatic notch.
l. Descending ramus of pubes.
m. Ascending ramus of ischium.
n. Anterior sacral foramen.
o. Tuber of ischium.
p. Internal condyles of knee-joint.
q. Patella.
r. Internal surface of tibia.
s. Internal malleolus.
t. Internal portion of annular ligament of ankle-joint.
u. Glutæus maximus.

1. Psoas major.
2. Iliacus internus.
3. Obturator internus.
4. Pyriformis; (5) Sartorius.
6. Adductor longus.
7. Gracilis; (8) Vastus internus.
9. Rectus femoris.
10. Adductor magnus.
11. Semimembranosus.
12. Semitendinosus.
13. Gastrocnemius (internal head).
14. Soleus; (15) Tendon of Achillis.
16. Flexor digitorum communis longus perforans.
17. Flexor pollicis pedis longus.
18. Tibialis posticus
19. Tendo tibialis antici.
20. Tendo extensoris pollicis pedis longi.
21. Adductor pollicis pedis.

Fig. 1.

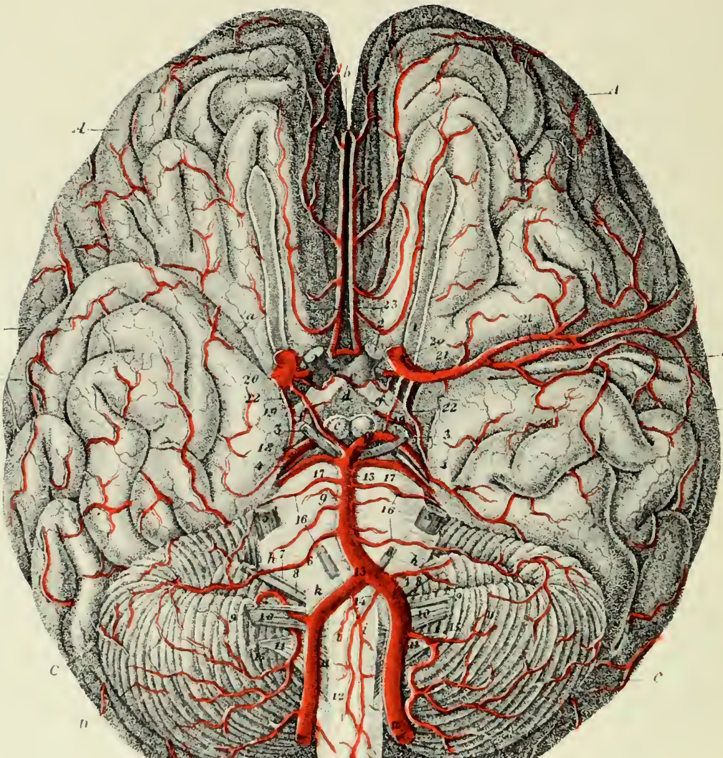


PLATE XVI.

BASE AND INTERIOR OF BRAIN, WITH ORIGINS OF NERVES AND BLOOD VESSELS.

Fig. 1.—Base of Brain, Showing Origins of Nerves and Arteries.

A. Anterior lobe of cerebrum.
B. Middle lobe of cerebrum.
C. Posterior lobe of cerebrum.
D. Cerebellum (arbor vitæ).
E. Medulla oblongata.

a. Fissure of Sylvius.
b. Longitudinal fissure of cerebrum.
c. Commissure of optic nerves.
d. Tuber cinereum.
e. Corpora mammillaria v. candicantia.
f. Optic tract.
g. Pons Varolii.
h. Crus cerebelli ad pontem.
i. Pyramidal body.
k. Olivary body.

Nerves.

1. Olfactory (first pair).
2. Optic (second pair).
3. Motor oculi (third pair).
4. Pathetic (fourth pair).
5. Trigeminus (fifth pair).
6. Abducens (sixth pair).
7. Facial, portio dura of seventh pair.
8. Auditory, portio mollis of seventh pair.
9. Glossopharyngeal of eighth pair.
10. Pneumogastric of eighth pair.
11. Lingual or hypoglossal (ninth pair).

Arteries.

12. Vertebral.
13. Basilar.
14. Anterior spinal.
15. Posterior inferior cerebellar.
16. Anterior inferior cerebellar.
17. Superior cerebellar.
18. Deep cerebral.
19. Communicating branches (forming with anterior cerebral, internal carotid, and posterior or deep cerebral arteries, the circle of Willis).
20. Internal carotid.
21. Fossæ of Sylvius.
22. Choroid.
23. Corporis callosi.

Fig. 2.

PLATE XVII.

BASE AND INTERIOR OF BRAIN, WITH ORIGINS OF NERVES AND BLOOD VESSELS—(Continued).

Fig. 2.—Vertical Longitudinal Section of Brain, Cerebrum, and Cerebellum, through Center.

I. Frontal bone and frontal sinus.
II. Crista galli.
III. Perpendicular lamina of ethmoid bone.
IV. Body of sphenoid.
V. Posterior clinoid process.
VI. Sella turcica.
VII. Sphenoidal sinus.
VIII. Basilar part of occipital bone.
IX. Occipital part of occipital bone.
X. Vomer.
XI. Roof of pharynx.
XII. Tentorium cerebelli enclosing straight sinus.

A.—E. Same as Fig. 1.

a. Convolutions of cerebrum.
b. Sulci.
c. Corpus callosum.
d. Genu corporis callosi.
e. Splenium corporis callosi
f. Septum lucidum.
g. Fornix.
h. Anterior crus.
i. Foramen of Monro.
k. Thalamus of optic nerve.
l. Anterior commissure.
m. Soft commissure.
n. Posterior commissure.
o. Pineal gland.
p. Peduncle or crus of pineal gland.
q. Corpora quadrigemina.
r. Pons Varolii.
s. Aquæduct of Sylvius.
t. Tuber cinereum.
u. Infundibulum.
v. Pituitary gland.
w. Commissure of optic nerves.
x. Optic nerve.
y. Fourth ventricle.
z. Corpus mammillare v. candicans.
α. Anterior valve of cerebellum.
β. Art. corporis callosi.

Fig. 1.

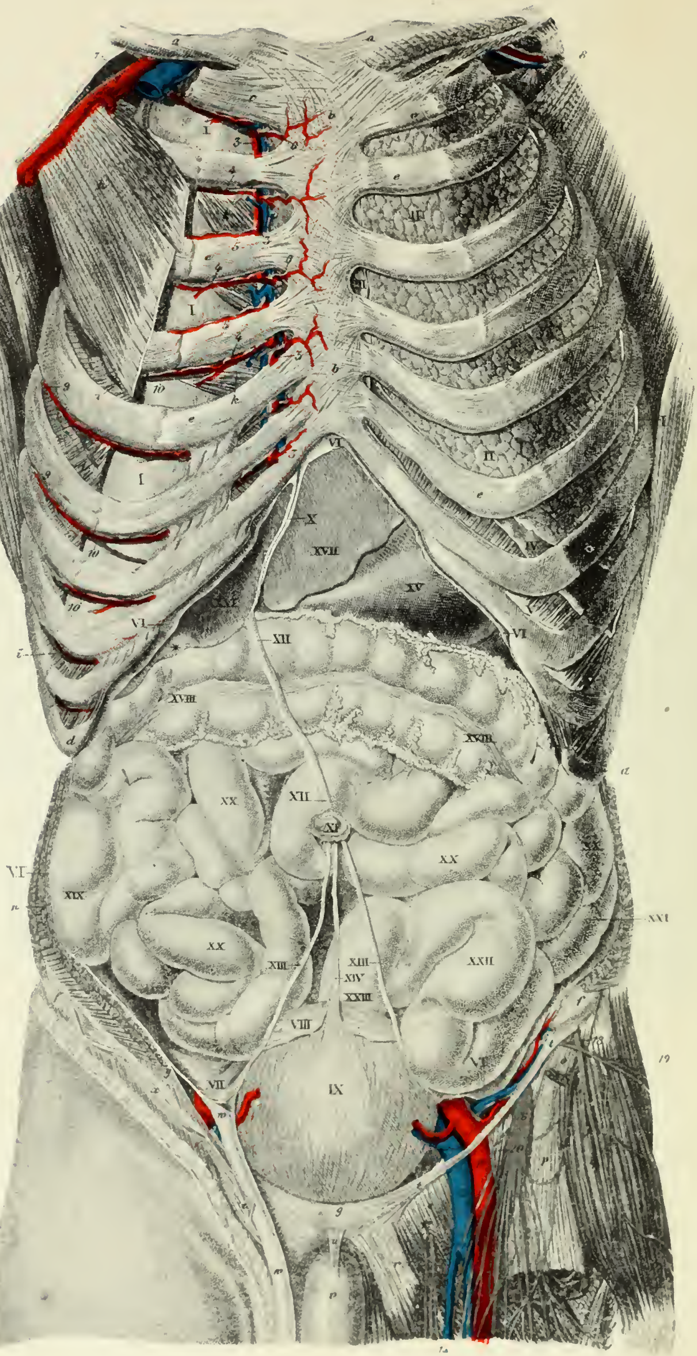


PLATE XVIII.

VISCERA OF THORAX, ABDOMEN AND PELVIS (ANTERIOR VIEW).

Fig. 1.—Thoracic Parietes with Viscera Enclosed (Abdomen and Abdominal Viscera in Natural Position).

a. Clavicle.
b. Sternum.
c. First rib.
d. Tenth rib.
e. Costal cartilages.
f. Ilium
g. Os pubis.

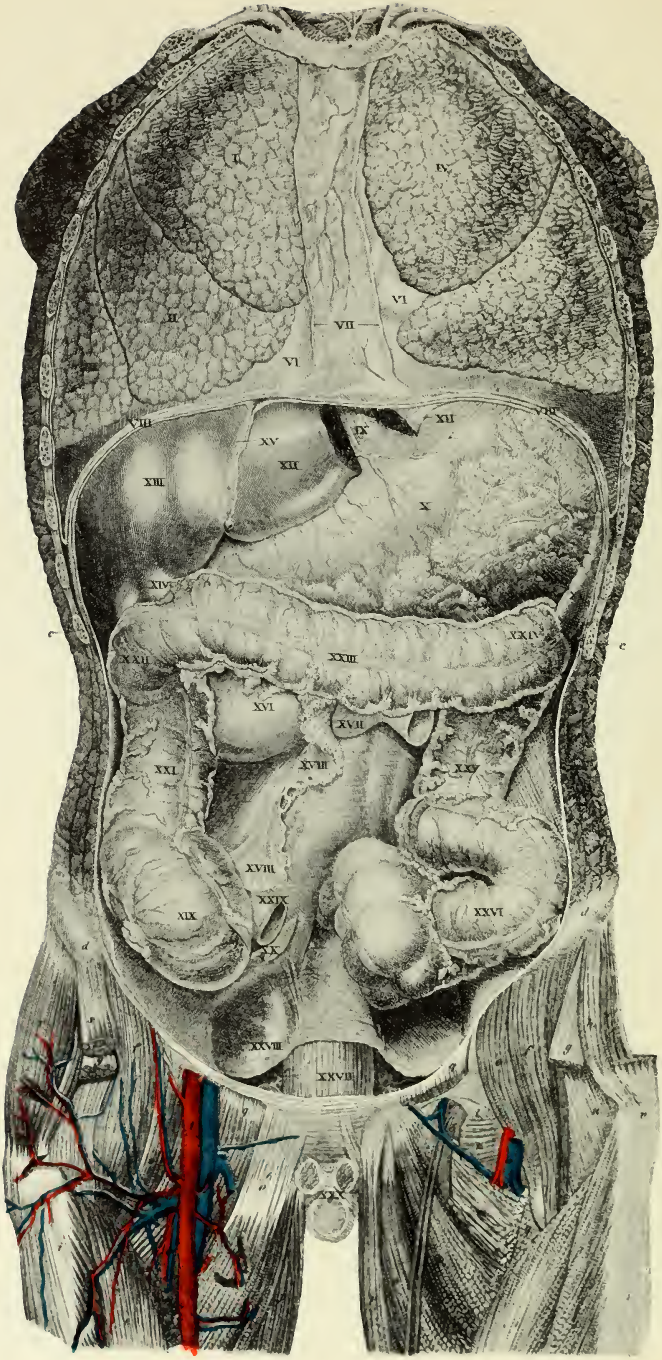
Muscles.

h. Pectoralis minor.
i. Internal intercostal.
k. Triangular of sternum.
l. Subscapular.
m. Latissimus dorsi.
n. Abdominal (oblique external and internal, and transversalis).
o. Sartorius.
p. Rectus femoris.
q. Tensor fasciæ latæ.
r. Adductor femoris longus.
s. Pectinæus.
t. Poupart's ligament.
w. Spermatic cord.
x. Divided margin of obliquus externus.
y. Fascia transversalis.
z. Inferior pillar of external abdominal ring (annulus abdominalis).

1. Axillary artery.
2. Axillary vein.
3. Internal mammary art. and ven.
4. Superior anterior intercostal artt.
5. Inferior anterior intercostal artt.
6. Sternal branches of internal mammary art.
7. Brachial plexus.
8. Transverse art. and ven. of the scapula, with suprascapular nerve.
9. Posterior intercostal artt.
10. Intercostal nerves.
11. Crural artery.
12. Crural vein.
13. Epigastric art. and ven.
14. Great saphenous vein.
15. Circumflex art. and ven. of ilium.
16. Crural nerve.
17. Anterior branch of the obturator nerve.
18. Anterior external cutaneal nerve of the thigh.
19. Cutaneal branch of the ilio-hypogastric nerve.
20. Lumbo-inguinal nerve.

I. Costal pleura.
II. Left lung.
III. Anterior mediastinum.
IV. Phrenic pleura.
V. Diaphragm.
VI. Peritoneum.
VII. External inguinal fossa.
VIII. Peritoneal coat of
IX. Urinary bladder.
X. Suspensory ligament of liver.
XI. Umbilicus.
XII. Round ligament of liver (obliterated umbilical vein).
XIII. Lateral ligaments of bladder (obliterated umbilical arteries).
XIV. Middle ligament of bladder (obliterated urachus).
XV. Stomach.
XVI. Right lobe of liver (with gall bladder).
XVII. Left lobe of liver (with gall bladder).
XVIII. Transverse colon.
XIX. Cæcum.
XX. Jejunum and ilium.
XXI. Descending colon.
XXII. Sigmoid flexure.
XXIII. Rectum.

Fig. 2.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XXVIII
XXVII

PLATE XIX.

VISCERA OF THORAX, ABDOMEN, AND PELVIS (ANTERIOR VIEW — Continued).

Fig. 2.—Lungs, in Position, and Deeper Abdominal Viscera (Small Intestine Being Removed).

a. Clavicle.
b. First rib.
c. Eleventh rib.
d. Crest of ilium.

Muscles.

a. Psoas major.
f. Internal iliac.
g. Rectus femoris.
h. Glutæus medius.
i. Vastus externus.
k. External obturator.
l. Obturator ligament.
m. Adductor magnus.
n. Adductor brevis.
o. Adductor longus.
p. Gracilis.
q. Pectinæus.
r. Tensor fasciæ latæ.
s. Sartorius.
t. Crural.
u. Neck of femur.
v. Trochanter major.

1. Crural artery.
2. Crural vein.
3. Superficial epigastric art. and ven.
4. Deep art. and ven. of thigh.
5. External circumflex art. and ven. of thigh.
6. Obturator nerve.

I. Superior lobe of right lung.
II. Middle lobe of right lung.
III. Inferior lobe of right lung.
IV. Superior lobe of left lung.
V. Inferior lobe of left lung.
VI. Pleura.
VII. Anterior mediastinal space.
VIII. Diaphragm.
IX. Esophagus.
X. Stomach.
XI. Spleen.
XII. Left lobe of liver (a portion of left extremity being removed).
XIII. Right lobe of liver.
XIV. Gall bladder.
XV. Suspensory ligament of liver.
XVI. Duodenum.
XVII. Jejunum.
XVIII. Mesentery.
XIX. Cæcum.
XX. Vermiform appendix.
XXI. Ascending colon.
XXII. Right flexure of colon.
XXIII. Transverse colon.
XXIV. Left flexure of colon.
XXV. Descending colon.
XXVI. Sigmoid flexure of colon.
XXVII. Rectum.
XXVIII. Peritoneum.
XXIX. Ilium (divided).

Fig. 1.

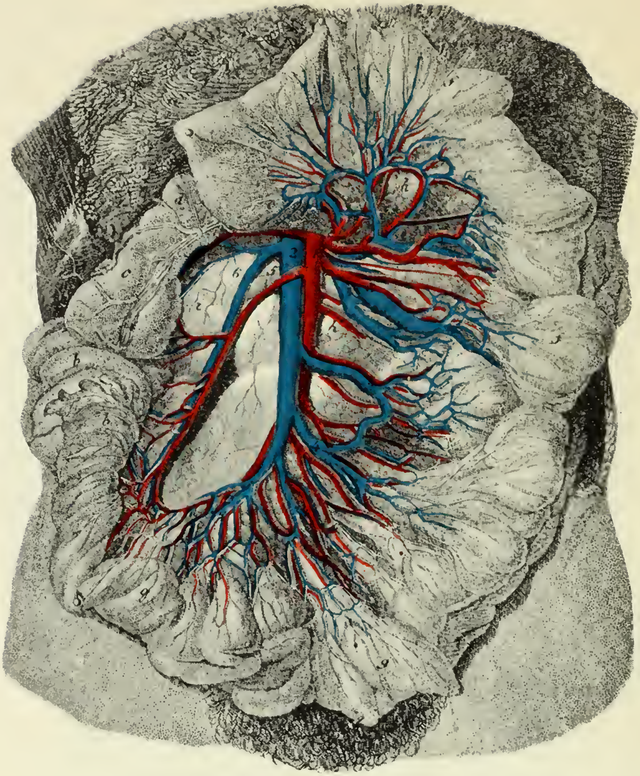


Fig. 2.

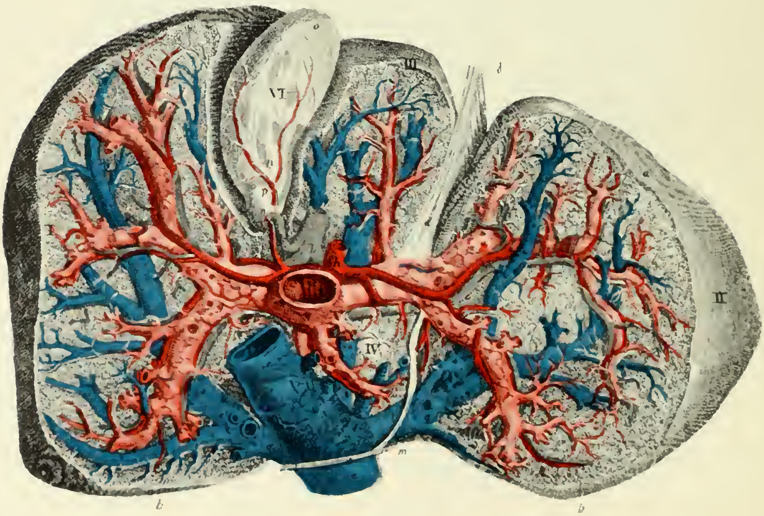


PLATE XX.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD VESSELS OF ABDOMINAL VISCERA.

Fig. 1.—Small Intestine (Jejunum and Ilium), Mesentery, and Mesenteric Vessels.

a. Omentum (raised and thrown back).
b. Cæcum.
c. Ascending colon.
d. Transverse colon.
e. Commencement of jejunum.
f. Jejunum.
g. Ilium.
h. Mesentery.
i. Right mesocolon.

1. Superior mesenteric artery.
2. Large mesenteric vein.
3. Jejunal arteries and veins.
4. Ileac arteries and veins.
5. Ileo-colic arteries and veins.
6. Right colic arteries and veins.

Fig. 2.—Internal Arrangement of Hepatic Blood Vessels, the Liver Being Divided Transversely.

I. Right lobe.
II. Left lobe.
III. Lobus quadratus.
IV. Lobus Spigelii.
V. Porta hepatis.
VI. Gall bladder.

a. Anterior margin.
b. Posterior margin.
c. Suspensory ligament of liver.
d. Round ligament of liver (in fossa umbilicalis).
e. Inferior vena cava.
f. Fossa ductus venosi.
g. Portal vein.
h. Hepatic artery.
i. Choledoch duct.
k. Cystic duct.
l. Hepatic duct.
m. Ductus venosus.
n. Cystic duct.
o. Fundus of gall bladder.
p. Collum of gall bladder.
q. Hepatic veins.

Fig. 3.

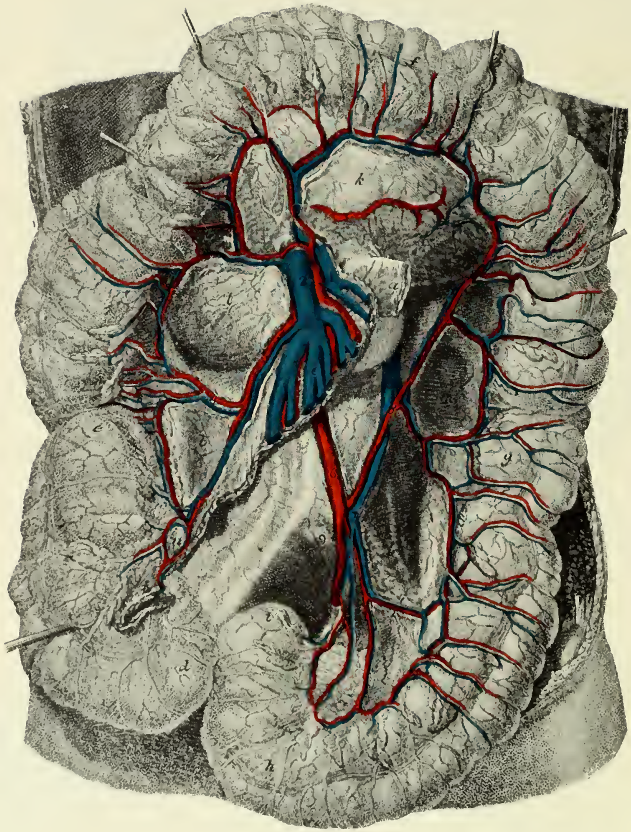


PLATE XXI.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD VESSELS OF ABDOMINAL VISCERA—(Continued).

Fig. 3.—Large Intestine, with Principal Blood Vessels.

a. Divided end of jejunum.
b. Divided end of ilium.
c. Mesentery (divided), with principal blood vessels.
d. Cæcum.
e. Ascending or right colon.
f. Transverse colon.
g. Descending or left colon.
h. Sigmoid flexure of colon.
i. Commencement of rectum.
k. Transverse mesocolon.
l. Right mesocolon.
m. Left mesocolon.
n. Mesocæcum.

1. Superior mesenteric artery.
2. Great mesenteric vein.
3. Middle colic artery and vein.
4. Right colic artery and vein.
5. Ileo-colic artery and vein.
6. Inferior mesenteric artery.
7. Minor mesenteric vein.
8. Left colic artery and vein.
9. Internal hemorrhoidal artery and vein.

Fig. 4.

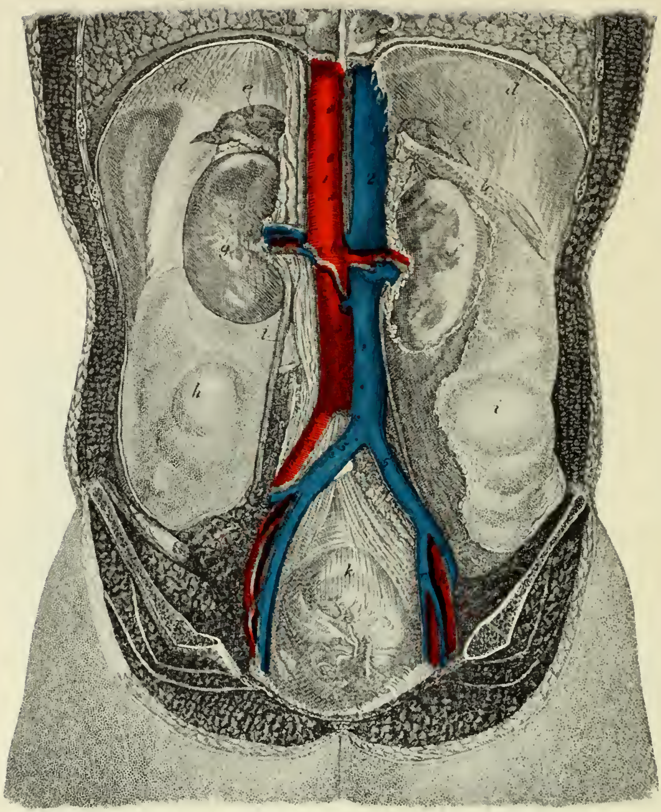


Fig. 5.

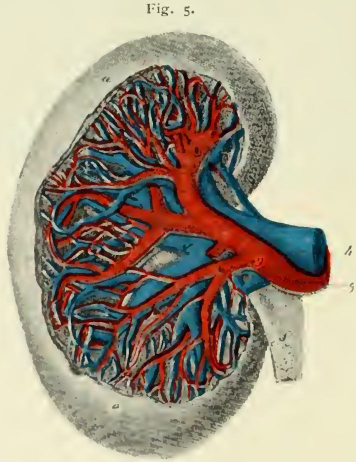


PLATE XXII.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD VESSELS OF ABDOMINAL VISCERA—(Continued).

Fig. 4.—View of Posterior Surface of Deep Viscera of Abdomen and Pelvis, with Principal Blood Vessels.

a. Tenth dorsal vertebra.
b. Last rib.
c. Ilium.
d. Diaphragm.
e. Suprarenal gland.
f. Right kidney.
g. Left kidney.
h. Sigmoid flexure of colon.
i. Ascending colon and cæcum.
k. Rectum.

1. Descending abdominal aorta.
2. Inferior vena cava.
3. Renal artery and vein.
4. Common iliac artery.
5. Common iliac vein.
6. Internal iliac artery.
7. Internal iliac vein.
8. External iliac vein.

Fig. 5.—Internal Structure of Kidney, with Blood Vessels and Ducts.

a. Cortical, cineritious or secreting surface (with tubuli contorti and Malpighian corpuscles).
b. Pyramid.
c. Mammillary process.
d. Calyx renalis.
e. Pelvis renalis.
f. Ureter.
g. Renal artery.
h. Renal vein.

Fig. 6.

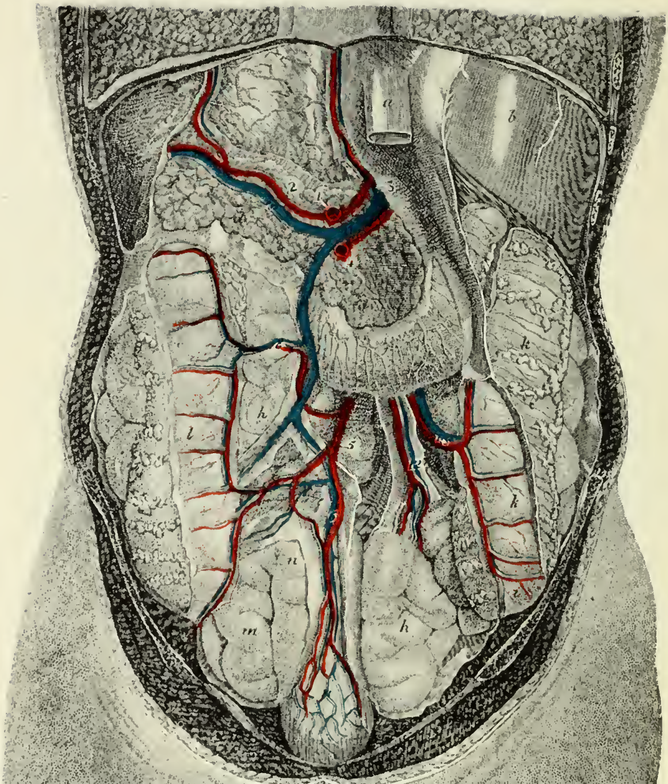


PLATE XXIII.

PRINCIPAL ORGANS OF DIGESTION, WITH DEEPER BLOOD VESSELS OF ABDOMINAL VISCERA — (Continued).

Fig. 6.—View of Posterior Surface of Superficial Viscera of Abdomen and Blood Vessels.

a. Inferior vena cava.
b. Liver.
c. Spleen.
d. Pancreas.
e. Head of pancreas.
f. Tail of pancreas.
g. Duodenum.
h. Ileum.
i. Cæcum.
k. Ascending colon.
l. Descending colon.
m. Sigmoid flexure of colon.
n. Rectum.

Arteries.

1. Cœliac.
2. Splenic.
3. Hepatic.
4. Superior mesenteric.
5. Inferior mesenteric.
7. Left colic.

Veins.

8. Left colic.
9. Minor mesenteric.
10. Splenic.
11. Great mesenteric.

Arteries and Veins.

6. Internal hemorrhoidal.
12. Ilio-colic.
13. Right colic.

Fig. 1.

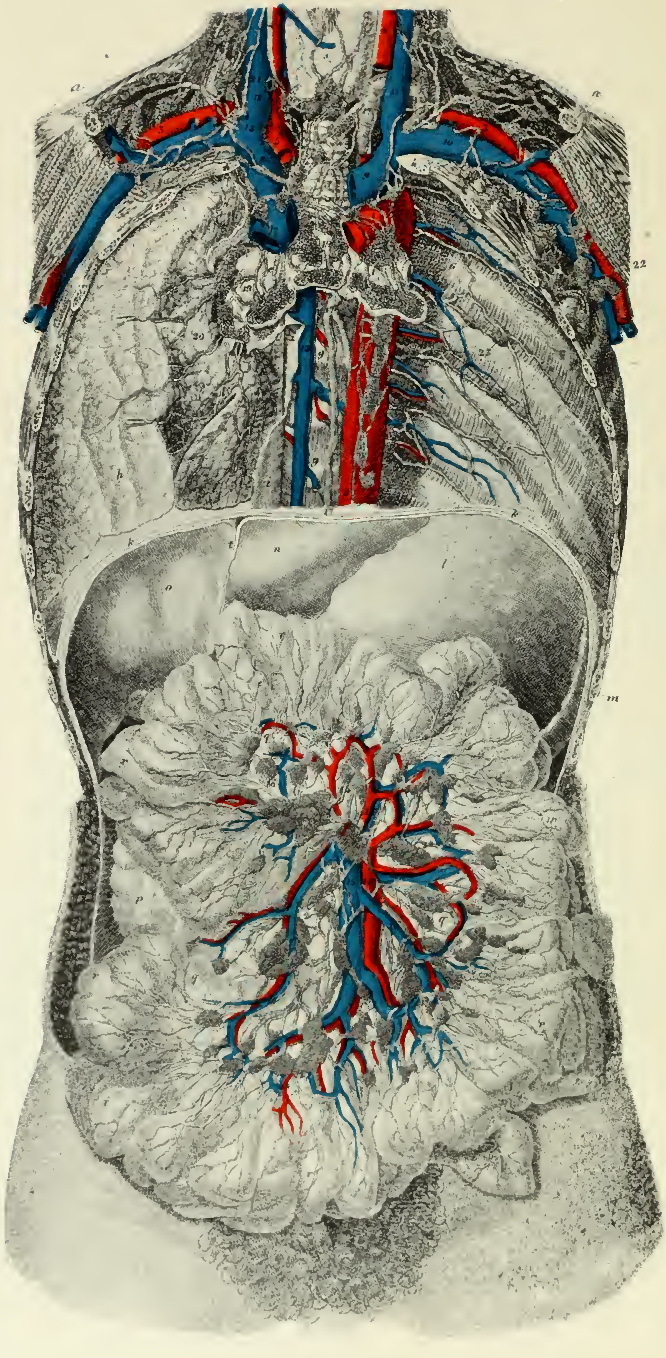


PLATE XXIV.

THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS, NERVES, AND LYMPHATICS.

Fig. 1.—Anterior View.

a. Clavicle.
b. First rib.
c. Thyroid gland.
d. Trachea.
e. Right bronchus.
f. Left bronchus.
g. Dorsal spine.
h. Right lung.
i. Posterior mediastinum.
k. Diaphragm.
l. Stomach.
m. Spleen.
n. Left lobe of liver.
o. Right lobe of liver.
p. Ascending colon.
q. Mesentery.
r. Jejunum and ileum.
s. Gall bladder.
t. Suspensory ligament of liver.

Arteries.

1. Arch of aorta.
2. Descending thoracic aorta.
3. Subclavian.
4. Common carotid.
5. Innominate.
6. Intercostal arteries and veins.
14. Mesenteric.

Veins.

7. Superior vena cava.
8. Right innominate.
9. Left innominate.
10. Subclavian.
11. Internal jugular.
12. Azygos.
13. Left lower azygos.
15. Great vein.
16. Jejunal and ileac arteries and veins.

Ducts and Glands.

17. Thoracic duct.
18. Right (minor) duct.
19. Bronchial glands.
20. Pulmonic glands.
21. Deep jugular glands.
22. Axillary glands.
23. Intercostal glands.
24. Mesenteric plexus with mesenteric glands.

Fig. 2.

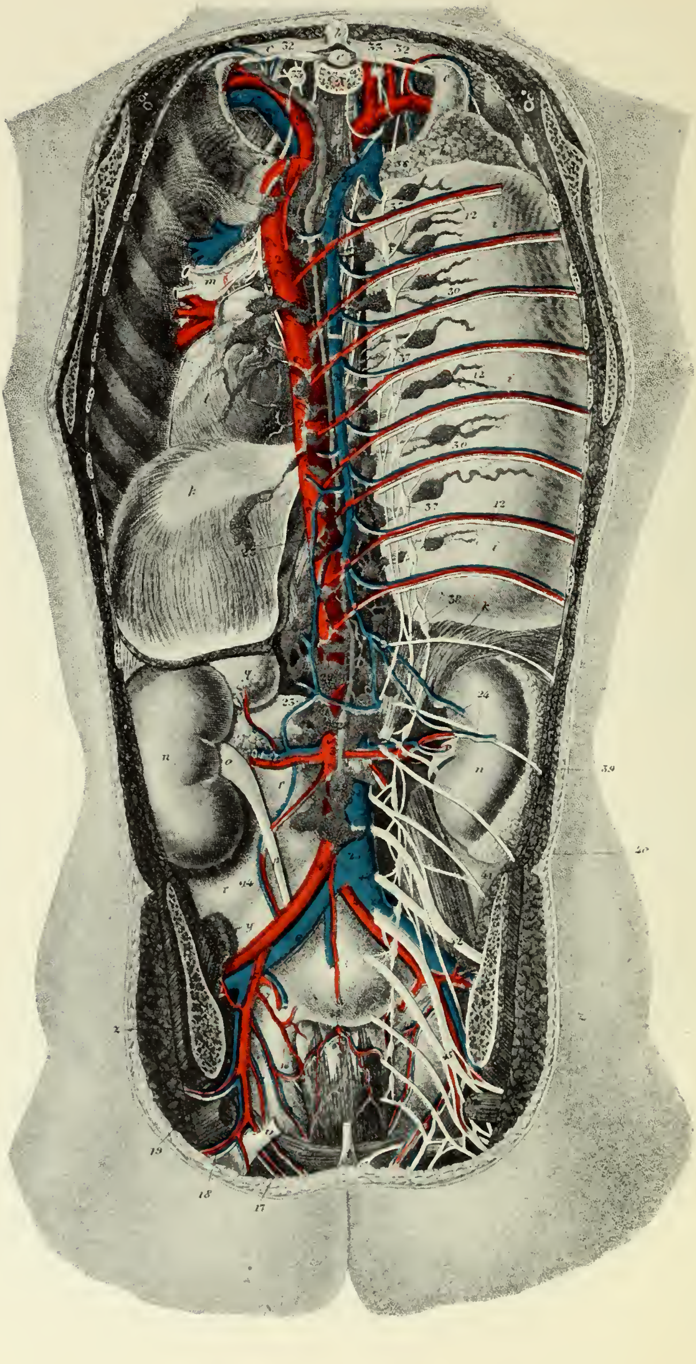


PLATE XXV.

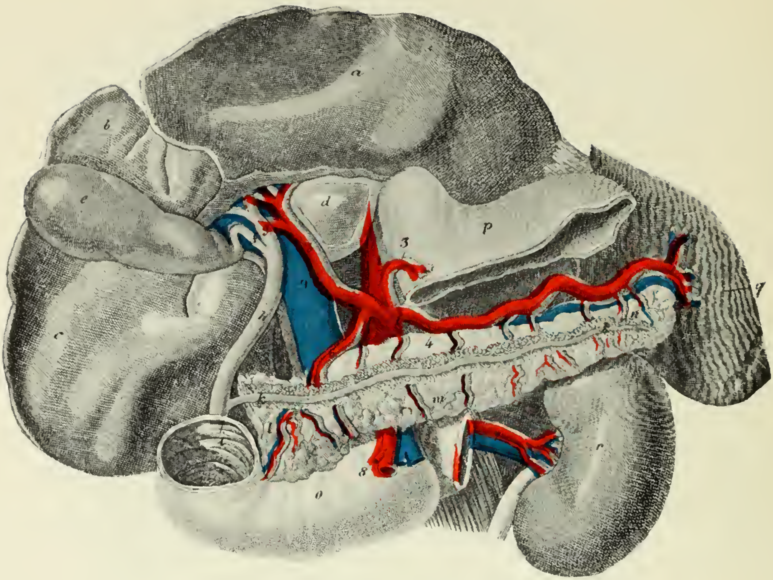
THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS, NERVES, AND LYMPHATICS—(Continued).

Fig. 2.—Posterior View.

a. Body of first dorsal vertebra.
b. Spinous process of first dorsal vertebra.
c. First rib.
d. Scapula.
e. Spinal cord.
f. Esophagus.
g. Trachea.
h. Apex of right lung.
i. Parietal layer of pleura.
k. Diaphragm.
l. Heart.
m. Left bronchus.
n. Kidney.
o. Pelvis renalis.
p. Ureter.
q. Suprarenal gland.
r. Peritoneum.
s. Rectum.
t. External sphincter ani muscle.
u. Levator ani muscle.
v. Great sacro-sciatic ligament.
w. Pyriform muscle.
x. Ilium.
y. Psoas major muscle.
z. Glutæus muscle.

1. Arch of aorta.
2. Descending thoracic aorta.
3. Descending abdominal aorta.
4. Common iliac artery.
5. Internal iliac artery and vein.
6. External iliac artery and vein.
7. Sacral median artery and vein.
8. Innominate artery.
9. Subclavian artery.
10. Common carotid artery.
11. Internal mammary artery and vein.
12. Intercostal arteries, veins, and nerves.
13. Renal artery and vein (with suprarenal branch).
14. Internal spermatic artery and vein.
15. Internal hemorrhoidal artery and vein.
16. Middle hemorrhoidal artery and veins.
17. Common pudic artery and vein.
18. Ischiadic artery and vein.
19. Superior glutæal artery and vein.
20. Subclavian vein.
21. Superior vena cava.
22. Azygos vein.
23. Left lower azygos vein.
24. Lumbar vein (1 and 2).
25. Inferior vena cava.
26. Common iliac vein.
27. Thoracic duct.
28. Receptacle of the chyle.
29. Lumbar glands.
30. Intercostal glands.
31. Posterior mediastinal glands.
32. Intercostal nerve (1).
33. Thoracic ganglion (1).
34. Pneumogastric (vagus) nerve.
35. Recurrent vagus nerve.
36. Phrenic nerve.
37. Thoracic part of sympathetic nerve (with thoracic ganglion).
38. Major and minor splanchnic nerve.
39. Intercostal nerves (12).
40. Lumbar nerve (1).
41. Anterior external cutaneous nerve of thigh.
42. Crural nerve.
43. Obturator nerve.
44. Lumbar ganglion of sympathetic nerve.
45. Ischiadic plexus.
46. Sacral nerves.

Fig. 3.



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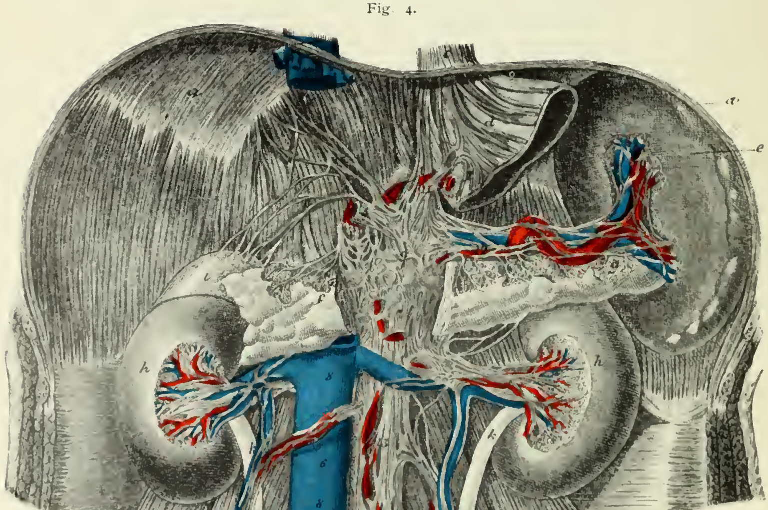


PLATE XXVI.

THORACIC AND ABDOMINAL VISCERA, WITH PRINCIPAL VESSELS, NERVES, AND LYMPHATICS — (Continued).

Fig. 3.—Principal Chylopoietic Viscera, Blood Vessels, and Ducts.

a. Left lobe of liver (under surface).
b. Lobus quadratus of liver (under surface).
c. Right lobe of liver (under surface).
d. Lobus Spigelii of liver (under surface).
e. Gall bladder.
f. Cystic duct.
g. Hepatic duct.
h. Ductus communis choledochus.
i. Descending part of duodenum, with place of entrance of choledoch duct.
k. Pancreatic duct.
l. Head of pancreas.
m. Body of pancreas.
n. Tail of pancreas.
o. Inferior horizontal part of duodenum.
p. Stomach.
q. Spleen.
r. Left kidney.

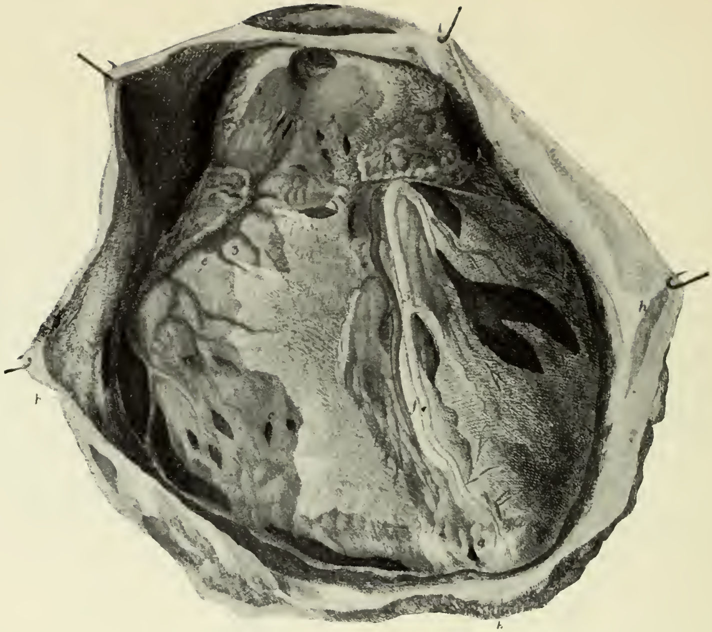
1. Descending abdominal aorta.
2. Cœliac axis artery.
3. Left coronary artery of ventricle.
4. Splenic and pancreatic arteries.
5. Hepatic artery.
6. Gastro-duodenal arteries.
7. Renal artery and vein.
8. Superior mesenteric artery and vein.
9. Portal vein.

Fig. 4.—Posterior View of Solar Plexus and Minor Plexuses, with Some of the Deep Blood Vessels.

a. Diaphragm.
b. Inferior vena cava (with hepatic veins).
c. Esophagus.
d. Stomach divided (with branches of par vagum).
e. Spleen.
f. Head of pancreas.
g. Tail of pancreas.
h. Kidney.
i. Suprarenal gland.
k. Ureter.

1. Descending abdominal aorta.
2. Left coronary of ventricle.
3. Splenic artery.
4. Hepatic artery (with hepatic plexus).
5. Renal artery and vein (with renal plexus.)
6. Internal spermatic artery and vein (with internal spermatic plexus).
7. Superior mesenteric artery.
8. Inferior vena cava.
9. Solar (cœliac) plexus.
10. Phrenic plexus.
11. Gastric plexus.
12. Splenic plexus.
13. Superior aortic (abdominal) plexus.

Fig. 1.



Fig, 2.

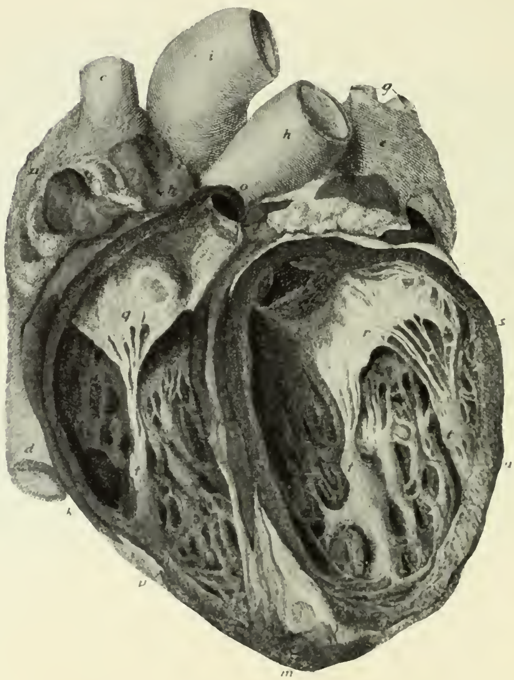


PLATE XXVII.

THE HEART, ITS CAVITIES AND VALVES.

Fig. 1.—Anterior Surface of Heart and Pericardial Covering.

a. Appendix of right auricle.
b. Appendix of left auricle.
c. Right ventricle.
d. Left ventricle.
e. Transverse or auriculo-ventricular groove.
f. Anterior longitudinal sulcus.
g. Apex of heart.
h. Pericardium divided and thrown back.

1. Pulmonary artery.
2. Ascending aorta.
3. Right coronary artery.
4. Front branch of left coronary artery.
5. Commencement of great coronary vein.

Fig. 2.—Internal Cavities of Ventricles—Anterior View.

a. Right auricle.
b. Appendix of right auricle.
c. Superior vena cava.
d. Inferior vena cava.
e. Left auricle.
f. Appendix of left auricle.
g. Pulmonary veins.
h. Pulmonary arteries.
i. Ascending aorta.
k. Right ventricle.
l. Left ventricle.
m. Apex of heart.
n. Wall of the ventricles.
o. Opening of pulmonary artery.
p. Opening of aorta.
q. Tricuspid or right auriculo-ventricular valve.
r. Bicuspid or left auriculo-ventricular valve.
s. Tendinous cords.
t. Musculi pectinati.
u. Fleshy surface of cut edge of right ventricle.

Fig. 1.

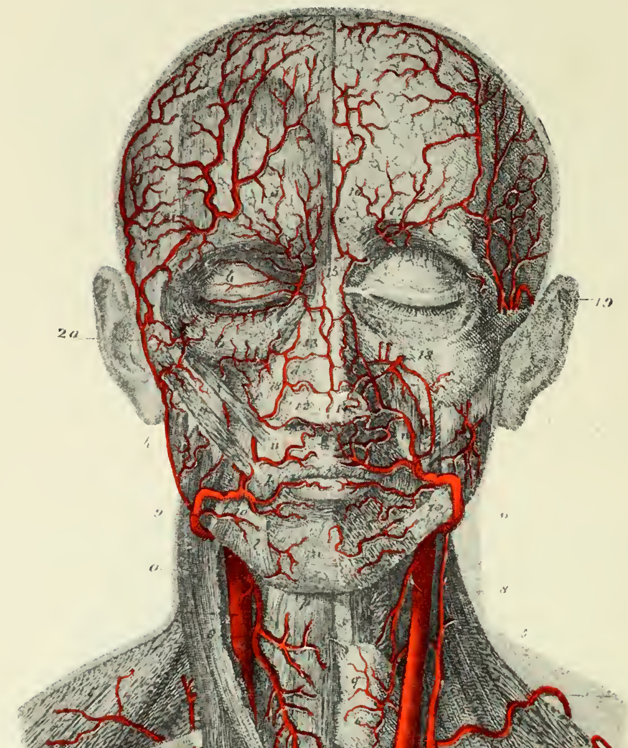


PLATE XXVIII.

BLOOD VESSELS OF HEAD AND NECK.

Fig. 1.—Arteries of Anterior Surface of Head and Neck.

Muscles.

a. Occipito-frontalis.
b. Orbicularis palpebrarum.
c. Corrugator supercilii.
d. Levator labii superioris alæque nasi.
e. Levator labii superioris proprius.
f. Zygomaticus minor.
g. Zygomaticus major.
h. Masseter.
i. Buccinator.
k. Orbicularis oris.
l. Triangularis menti.
m. Quadratus menti.
n. Levator anguli oris.
o. Sterno-cleido-mastoid.
p. Sterno-hyoid.
t. Trapezius.
u. Omo-hyoid.
v. Scalenus anticus.
w. Scalenus medius.
x. Clavicle.
q. Thyroid gland.
r. Trachea.
s. Larynx.

Arteries.

1. Subclavian.
2. Internal mammary.
3. Transverse scapular.
4. Transverse of neck.
5. Ascending cervical.
6. Inferior thyroid.
7. Common carotid.
8. Superior thyroid.
9. External maxillary or labial.
10. Coronary of lower lip.
11. Coronary of upper lip.
12. Angular.
13. Dorsals of nose.
14. Alaries of nose.
15. Ophthalmic.
16. Frontal.
17. Supraorbital.
18. Infraorbital.
19. Deep temporals (from internal maxillary).
20. Temporal (superficialis).
21. Frontal branch of temporal.

Fig. 2.

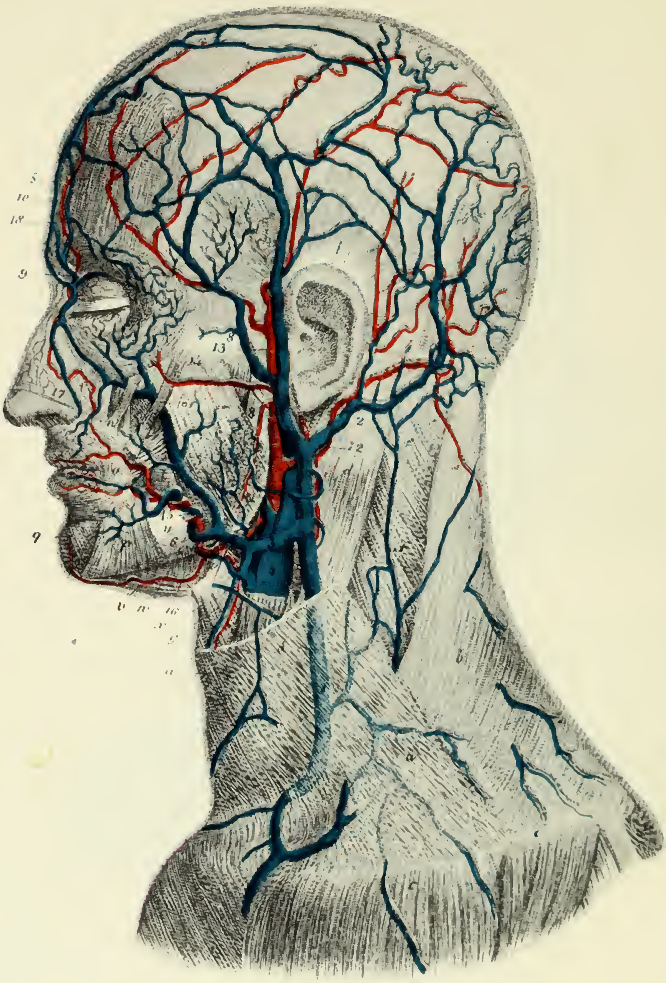


PLATE XXIX.

BLOOD VESSELS OF HEAD AND NECK — (Continued).

Fig. 2.—Arteries and Veins of Lateral Surface of Head, Face, and Neck.

Muscles.

a. Platysma-myoides.
b. Culcullaris v. trapezius.
c. Deltoid.
d. Sterno-cleido-mastoid.
e. Splenius capitis.
f. Splenius colli.
g. Occipital.
h. Retrahens auris.
i. Attollens auris.
k. Masseter
l. Buccinator.
m. Zygomaticus major
n. Zygomaticus minor.
o. Orbicularis oris.
p. Triangularis menti.
q. Quadratus menti.
r. Orbicularis palpebrarum.
s. Frontal.
t. Levator labii superioris alaeque nasi.
u. Lower jaw.
v. Digastricus maxillæ inferioris.
w. Mylo-hyoid.
x. Sterno-hyoid.
y. Omo-hyoid.

Veins.

1. External jugular.
2. Occipital.
3. Common branch, between external and internal jugular.
4. Internal jugular.
5. Anterior facial.
6. Labial.
7. Angular.
8. Temporal.
9. Cerebral ophthalmic.
10. Frontal.

Arteries.

11. External carotid.
12. Posterior auricular.
13. Temporal (superficial).
14. Transversa faciei.
15. External maxillary.
16. Submental.
17. Angular.
18. Frontal.

Fig. 3.

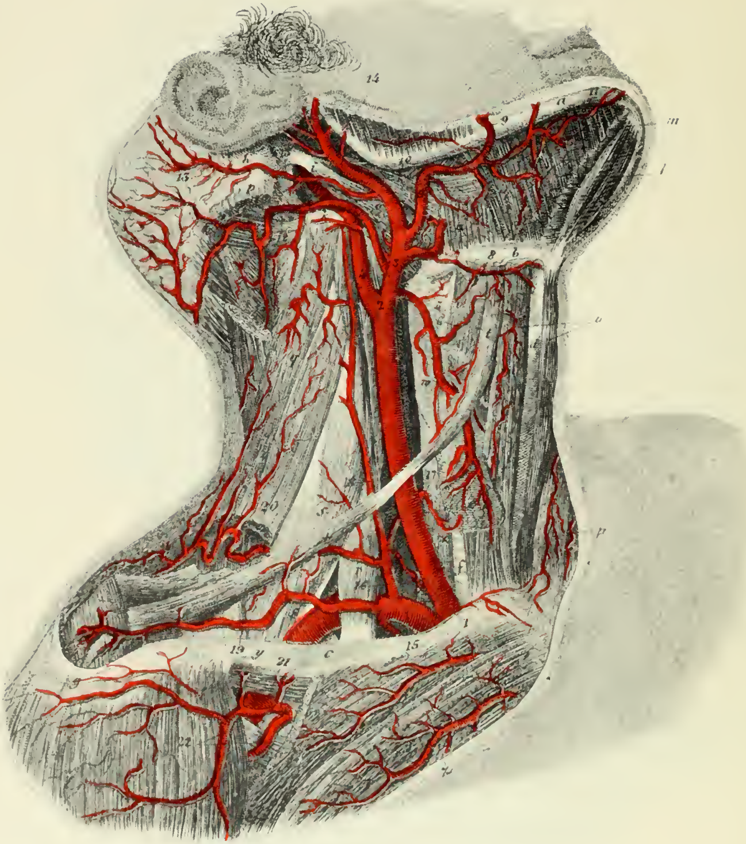


PLATE XXX.

BLOOD VESSELS OF HEAD AND NECK—(Continued).

Fig. 3.—Arteries of Right Side of Neck.

a. Inferior maxillary (lower jaw.)
b. Os hyoides.
c. Clavicle.
d. Larynx.
e. Thyroid gland.
f. Trachea.
g. Acromion scapulæ.
h. Mastoid process.
i. Styloid process.
k. Processus transversus atlantis.

Muscles.

l. Digastric (anterior belly).
m. Mylo-hyoid.
n. Hyo-glossus.
o. Stylo-glossus.
p. Sterno-cleido-mastoid.
q. Levator anguli scapulæ.
r. Scalenus anticus.
s. Scalenus medius.
t. Omo-hyoid.
u. Sterno-hyoid.
v. Thyro-hyoid.
w. Pharynx.
x. Esophagus.
y. Subclavian.
z. Pectoralis major.

Arteries.

1. Right common carotid.
2. Branching of right common carotid,
3. External carotid.
4. Internal carotid.
5. Superior thyroid.
6. Superior laryngeal.
7. Lingual.
8. Hyoid branch of lingual.
9. External maxillary or facial.
10. Ascending palatine.
11. Submental.
12. Occipital (with ascending and descending branches).
13. Posterior auricular.
14. Temporal (superficial).
15. Right subclavian.
16. Trunk of thyro-cervical.
17. Inferior thyroid.
18. Ascending cervical.
19. Transversalis humeri.
20. Transversalis colli.
21. Axillary.
22. External thoracic.

Fig. 4.

PLATE XXXI.

BLOOD VESSELS OF HEAD AND NECK — (Continued).

Fig. 4.—Arteries and Veins of Right Side of Neck.

a–x. As in Fig. 3.
y. First rib.
z. First bone of sternum.

Veins.

1. Superior vena cava.
2. Left innominate.
3. Right innominate.
4. Right subclavian.
5. Axillary.
6. External jugular.
7. Internal jugular.
8. Facial.
9. Internal maxillary.
10. Middle jugular.
11. Arch of aorta.

Arteries.

12. Innominate.
13. Right common carotid.
14. Right subclavian.
15. Axillary.
16. External carotid.
17. Internal carotid.
18. Superior thyroid.
19. Lingual.
20. External maxillary or facial.
21. Temporal.
22. Posterior auricular.
23. Occipital.
24. Inferior thyroid.
25. Transversalis humeri.
26. Transversalis colli.
27. External thoracic.

Fig. 1.

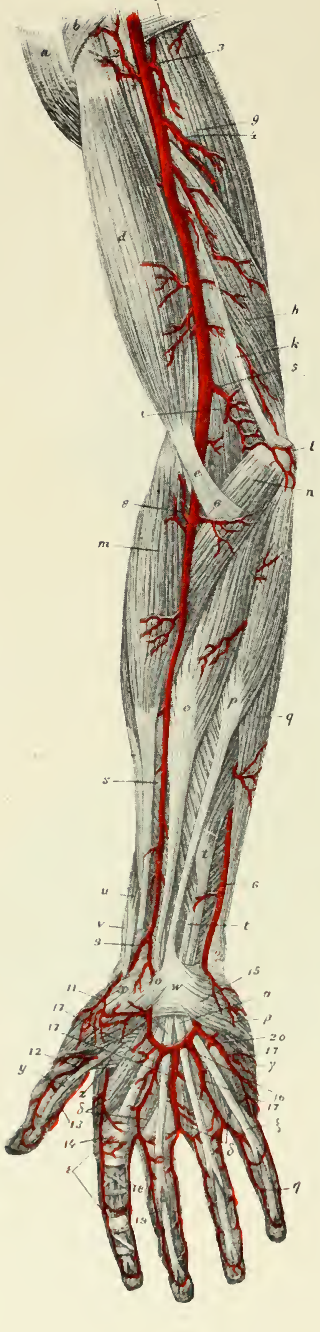


Fig. 2.

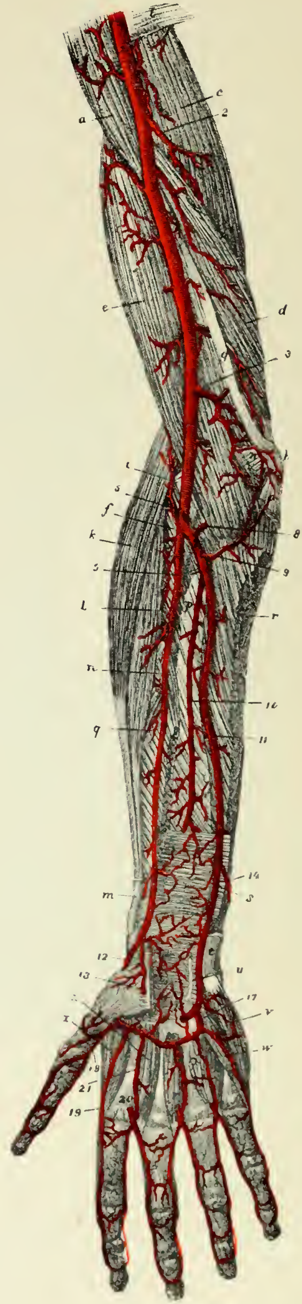


PLATE XXXII.

ARTERIES OF ANTERIOR SURFACE OF ARM, FOREARM, AND HAND.

Fig. 1.—Superficial Arteries on Internal and Anterior Surface of Arm, Forearm, and Hand.

Muscles.

a. Deltoid.
b. Pectoralis major.
c. Latissimus dorsi.
d. Biceps.
e. Semilunar fascia of biceps.
f. Coraco-brachialis.
g. Long head of triceps.
h. Short head of triceps.
i. Brachialis anticus.
k. Internal intermuscular ligament.
l. Internal condyle of humerus.
m. Supinator longus.
n. Pronator teres.
o. Flexor carpi ulnaris.
p. Palmaris longus.
q. Flexor carpi ulnaris.
r. Extensor carpi radialis longus.
s. Flexor pollicis longus.
t. Flexor digitorum communis sublimis.
*t.** Flexor digitorum communis profundis.
u. Abductor pollicis longus.
v. Extensor pollicis brevis.
w. Anterior annular ligament of wrist.
x. Ball of thumb, abductor and flexor brevis pollicis.
y. Tendon of flexor longus pollicis.
z. Abductor pollicis.

Arteries.

1. Brachial.
2. Muscular branches to coraco-brachial and biceps muscle.
3. Muscular branches to triceps.
4. Profunda superior brachii.
5. Anastomica magna.
6. Ulnar.
7. Radial.
8. Recurrent radial.
9. Dorsal branch of radial.
10. Volar branch of radial.
11. Muscular branch to ball of thumb.
12, 13, 14. Branches from princeps pollicis.
15. Volar branch of ulnar.
16. Superior arch of palm.
17. Common volar digital.
18. Volar ulnar.
19. Dorsal radial.
20. Deep or communicating branch.

Fig. 2.—Deep Arteries of Arm, Forearm and Hand — Anterior Surface.

Muscles.

a. Coraco-brachial.
b. Latissimus dorsi.
c. Long head of triceps.
d. Short head of triceps.
e. Brachialis anticus.
f. Supinator brevis.
g. Internal intermuscular ligament.
h. Internal condyle of humerus.
i. Tendon of biceps (divided).
k. Extensor carpi radialis longus.
l. Extensor caipi radialis brevis.
m. Tendon of long supinator (divided).
n. Radial insertion of pronator teres.
o. Origin of internal radial and palmaris longus.
p. Interosseus membrane.
q. Flexor polli is longus.
r. Flexor (divided).
s. Pronator quadratus.
t. Tendon of flexor carpi ulnaris (divided).
u. Anterior annular ligament (divided).
v. Abductor digiti minimi.
w. Opponens digiti minimi.
x. Interosseus.

Arteries.

1. Brachial.
2. Profunda superior brachii.
3. Anastomica magna.
4. Bifurcation of brachial.
5. Recurrent radial.
6. Radial.
7. Ulnar.
8. Anterior recurrent ulnar.
9. Posterior recurrent ulnar.
10. Interosseus.
11. Continuation of ulnar.
12. Dorsal branch of radial.
13. Superficialis volæ.
14. Dorsal branch of ulnar.
15. Section of communicating branch of ulnar.
16. Deep palmar arch.
17. Deep branch of ulnar.
18. Princeps pollicis.
19. Indicis radialis.
20. Digitalis communis (divided).
21. Interosseæ palmares.

Fig. 1.

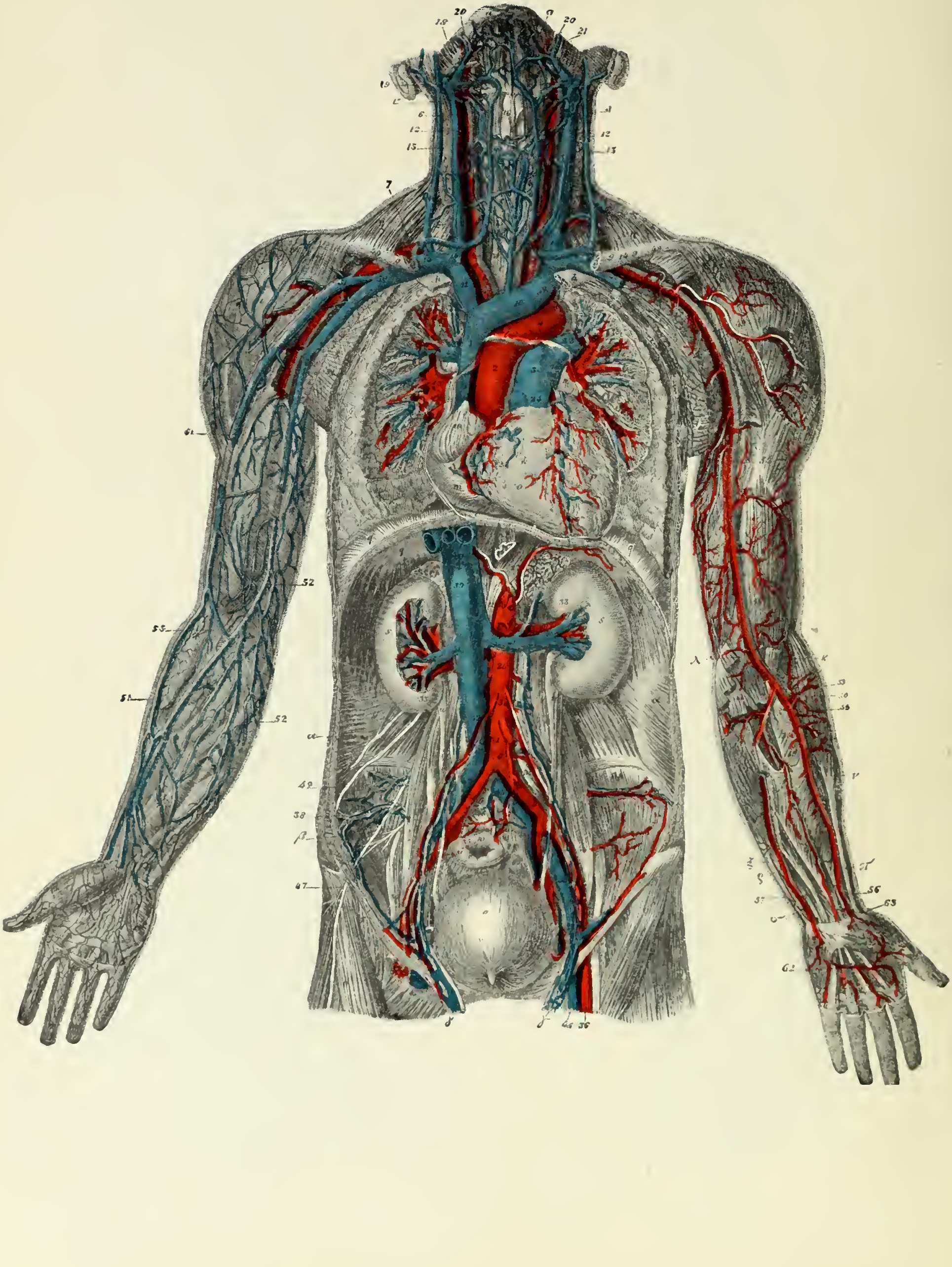


PLATE XXXIII.

BLOOD VESSELS OF NECK, TRUNK, AND UPPER EXTREMITIES.

Fig. 1.—Principal Arteries and Veins of Neck, Thorax, and Arms, with Deep Blood Vessels of Abdominal Cavity.

a. Lower jaw.
b. Os hyoid.
c. Larynx.
d. Thyroid gland.
e. Trachea.
f. Esophagus.
g. Clavicle.
h. First rib.
i. Lung.
k. Heart.
l. Pericardium.
m. Right auricle.
n. Left auricle.
o. Right ventricle.
p. Left ventricle.
q. Diaphragm.
r. Esophagus.
s. Kidney.
t. Suprarenal capsules.
u. Ureter.
v. Bladder.
w. Rectum.
x. Peritoneum

Muscles.

y. Quadratus lumborum.
α. Transverse abdominal.
β. Internal iliac.
γ. Spermatic cord.
δ. Sartorius.
ε. Poupart's ligament.
ζ. Pectoralis major.
η. Trapezius.
ϑ. Scalenus anticus.
ι. Deltoid.
z. Psoas.
κ. Flexor biceps of elbow.
λ. Brachialis anticus.
μ. Triceps extensor.
ν. Supinator longus.
ξ. Flexor carpi ulnaris.
π. Flexor pollicis longus.
ρ. Flexor digitorum communis profundus.
o. Pronator quadratus.

Arteries.

2. Ascending aorta.
3. Pulmonary.
4. Arch of aorta.
5. Innominate.
6. Right common carotid.
7. Right subclavian.
8. Left common carotid.
9. Left subclavian.
20. Facial (or labial).
22. Pulmonary.
26. Descending abdominal aorta.
27. Inferior phrenic.
28. Cœliac axis.
29. Superior mesenteric.
30. Internal spermatic.
31. Inferior mesenteric.
32. Internal hemorrhoidal.
34. Common iliac.
35. Internal iliac.
36. External iliac.
49. Axillary.
54. Brachial.
55. Branching of brachial.
56. Radial.
57. Ulnar.
58. Common interosseous.
59. Internal interosseus.
60. Recurrent radial.
61. Recurrent ulnar.
62. Deep palmar arch.
63. Superficial branch of radial.

Veins.

1. Superior vena cava.
10. Left innominate.
11. Right innominate.
12. Internal jugular.
13. External jugular.
14. Subclavian.
15. Superior thyroid.
16. Subcutaneæ colli.
17. Inferior thyroid.
18. Labial.
19. Posterior cephalic.
21. Anterior facial.
23. Pulmonary.
24. Anterior branch of left coronary of heart.
39. Inferior vena cava.
40. Hepatic.
41. Renal.
42. Internal spermatic.
43. Common iliac.
44. Internal iliac.
45. External iliac.
47. Nerve inguino cutaneus.
48. Nerve ilio-lumbalis.
50. Axillary.
51. Cephalic.
52. Basilic.
53. Median.

Arteries and Veins.

25. Right coronary of heart.
33. Renal.
37. Circumflex iliac.
38. Ilio-lumbar.
46. Sacra media.

Fig. 1.

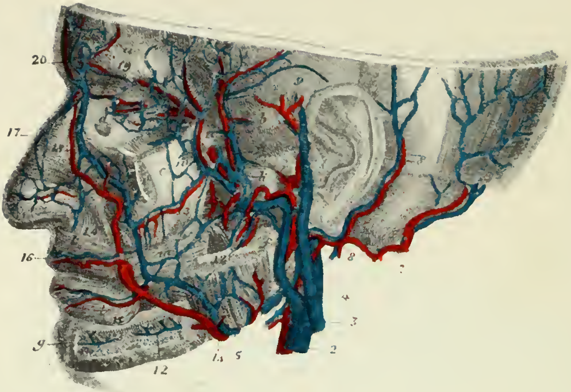


Fig. 2.

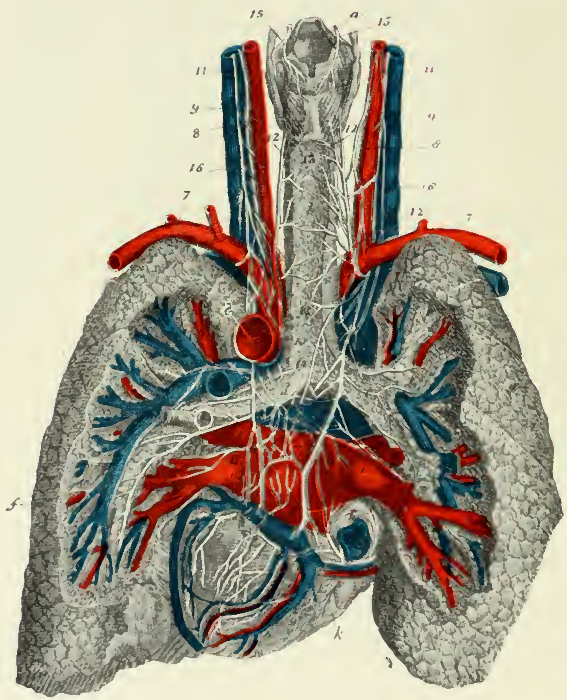


PLATE XXXIV.

BLOOD VESSELS OF FACE, NECK, TRACHEA, AND LUNGS.

Fig. 1.—Distribution of Internal Maxillary and Labial or Facial Arteries and Veins on Left Side of Head.

a. Frontal bone.
b. Great wing of sphenoid.
c. Upper maxillary.
d. Inner wall of orbit.
e. Malar bone.
f. Inferior maxillary.
g. Body of maxillary.

Muscles.

h. External pterygoid.
i. Internal pterygoid.
k. Masseter.
l. Orbicularis oris.
m. Buccinator.

Veins.

2. Internal jugular.
3. External jugular.
4. Labial.
5. Anterior facial.
6. Posterior facial.

Arteries and Veins.

7. Occipital.
8. Posterior auricular.
11. Deep temporal.
12. Inferior alveolar.
13. Posterior alveolar.
19. Cerebral ophthalmic.
20. Frontal.

Arteries.

1. Left common carotid.
9. Temporal (superficial).
10. Internal maxillary.
14. External maxillary.
15. Coronaria labii inferioris.
16. Coronaria labii superioris.
17. Dorsal of nose.
18. Angular.

Fig. 2.—Posterior Surface of Lungs and Trachea, with their Principal Arteries, Veins and Nerves.

a. Larynx.
b. Trachea.
c. Right bronchus.
d. Left bronchus.
e. Superior lobe of lung.
f. Inferior lobe of lung.
g. Middle lobe of lung.
h. Righ auricle, with orifice of inferior vena cava.
i. Left orifice.
k. Right ventricle.
l. Left ventricle.

Arteries.

3. Right coronary of heart.
4. Pulmonary.
5. Arch of aorta.
6. Innominate.
7. Subclavian.
8. Common carotid.

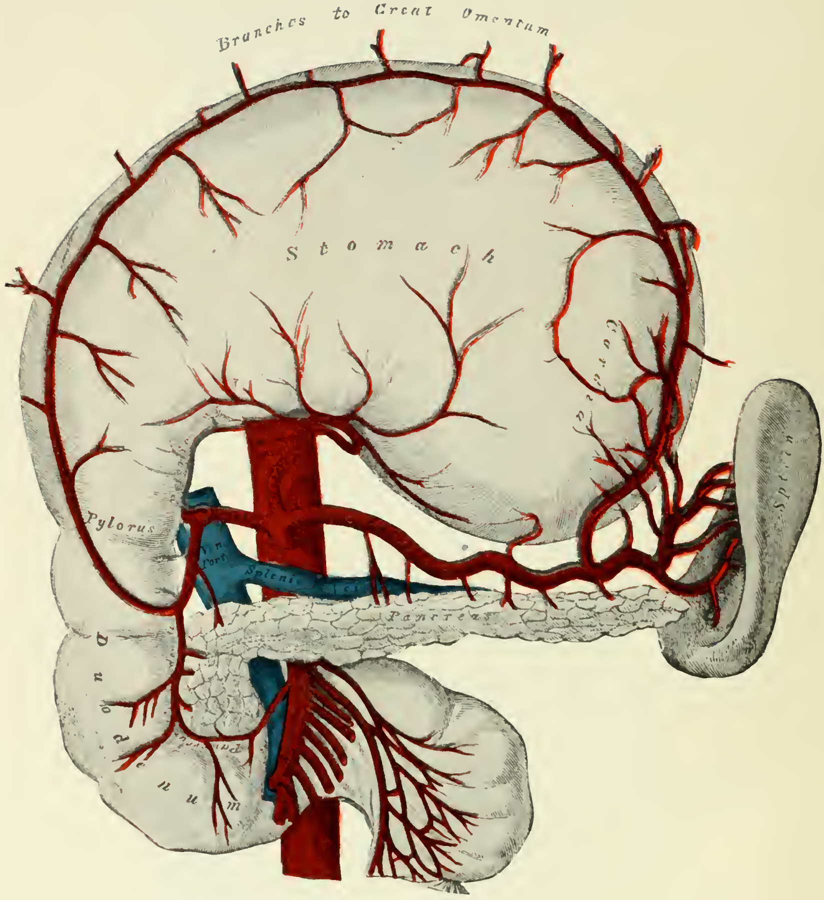
Veins.

1. Pulmonary.
2. Great vein of heart.
9. Internal jugular.
10. Superior vena cava.

Nerves.

11. Pneumogastric (vagus).
12. Recurrent laryngeal branch of pneumogastric.
13. Recurrent branches of tracheal.
14. Recurrent branches of cardiac.
15. Superior laryngeal.
16. Cardiac branch of sympathetic.
17. Cardiac plexus.

Fig. 1.



Branches to Great Omentum
Stomach
Pylorus
Pancreas
Spleen
Duodenum

PLATE XXXV.

CŒLIAC AXIS AND ITS BRANCHES.

Fig. 1.—The Cœliac Axis and Its Branches, and Their Ramifications, Pancreas, Spleen and Duodenum in Position, the Stomach Having Been Raised and the Transverse Mesocolon Removed.

The Cœliac Axis is a short, thick trunk, about half an inch in length, arising from the aorta opposite the margin of the diaphragm. It passes nearly horizontally forward and divides into three large branches — the gastric, hepatic and splenic. Occasionally it gives off one of the phrenic arteries.

The Splenic, in the adult, is the largest of the three branches. It takes a tortuous course to the left along the upper border of the pancreas, to which it gives off the pancreaticæ parvæ and pancrea magna. Its other branches are the gastric (vasa brevia) and left gastro-epiploica.

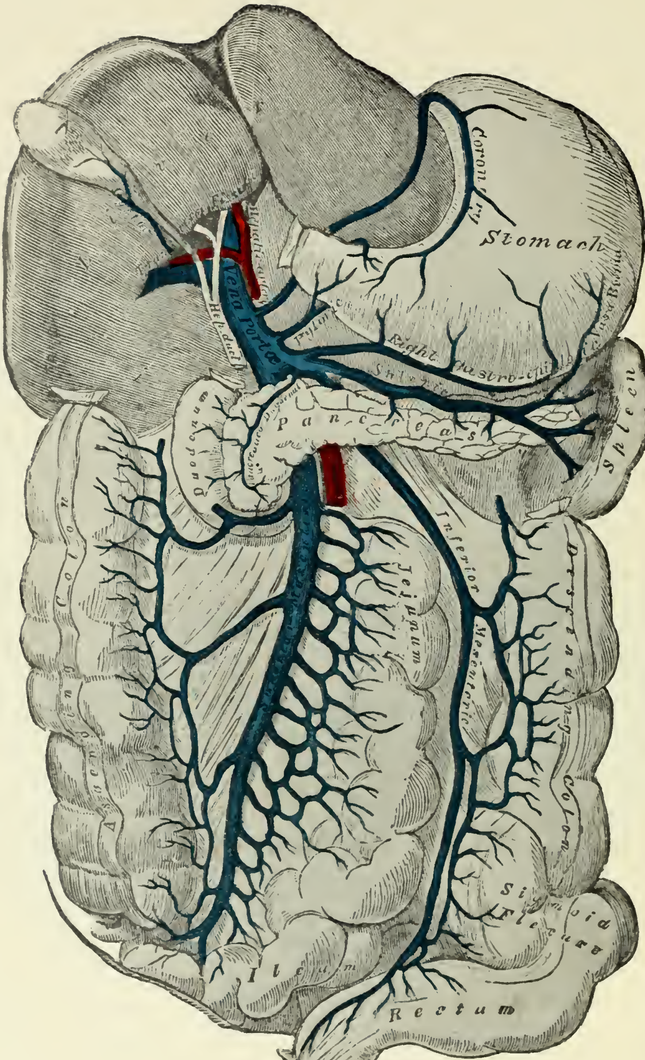
The Gastric (coronaria ventricula) is the smallest branch of the cœliac axis and distributes branches to the esophagus, cardiac end of the stomach, and, by its largest branch, to the stomach along its lesser curvature as far as the pylorus, as well as to the two layers of the lesser omentum, through which it passes.

The Hepatic, in the adult, ranges between the other two in size, but in the fœtus is the largest of the three. Its course is upward and to the right. It gives off the pyloric, gastro-duodenalis (which divides into the gastro-epiploica dextra and pancreatico-duodenalis superior), and cystic.

The branches from these arteries freely anastomose with each other and with other arteries to these members.

The Superior Mesenteric artery and the beginnings of its branches are also shown, as well as a portion of the portal and splenic veins.

Fig. 1,



Coronary
Stomach
Vena Portæ
Hep. duct
Right
Spleen
Pancreas
Duodenum
Colon
Inferior
Mesenteric
Jejunum
Descending
Colon
Ascending
Sigmoid
Flexure
Ileum
Rectum

PLATE XXXVI.

PORTAL SYSTEM OF VEINS.

Fig. 1.—Portal Vein and Its Branches, Liver, Stomach, Pancreas, Spleen, Portion of Large and Small Intestines in Position (Transverse Colon Removed).

The Portal Venous system is composed of four large veins which collect the venous blood from the digestive viscera. These are the inferior and superior mesenteric, splenic and gastric, which unite to form the portal vein (vena portæ), which is quite large in size, and extends from the pancreas to the stomach.

The Portal vein is about four inches long, being formed by the junction of the superior mesenteric and splenic veins, their union taking place in front of the vena cava and behind the upper border of the great end of the pancreas. Passing upwards through the right border of the lesser omentum to the under surface of the liver, it enters the transverse fissure, where it is somewhat enlarged, forming the sinus of the portal vein and divides into two branches, which accompany the ramifications of the hepatic artery and hepatic duct throughout the substance of the liver. The right is the larger but shorter branch. The portal vein lies behind and between the hepatic duct and artery, the former being to the right and the latter to the left. Filaments of the hepatic plexus of nerves and numerous lymphatics, surrounded by a quantity of loose areolar tissue, accompany these structures.

The Inferior Mesenteric returns the blood from the rectum, sigmoid flexure and descending colon. It ascends beneath the peritoneum in the lumbar region, passes behind the transverse portion of the duodenum and pancreas and terminates in the splenic vein. Its hemorrhoidal branches inosculate with those of the internal iliac, thus establishing a communication between the portal and general venous systems. Other anastomoses with veins of the systematic system also take place.

The Superior Mesenteric returns the blood from the small intestine, cæcum, and ascending and transverse colon. The large trunk, formed by the union of its numerous branches, ascends along the right side and in front of the corresponding artery, passes in front of the transverse portion of the duodenum, and unites behind the upper border of the pancreas, with the splenic vein to form the portal vein. Usually the right gastro-epiploic vein empties into the superior mesenteric close to its termination, but in the plate it opens into the splenic vein.

The Splenic commences by five branches which return the blood from the substance of the spleen. These form a single vessel which passes from left to right behind the upper border of the pancreas below the artery and terminates at its greater end by uniting at a right angle with the superior mesenteric to form the vena portæ. It is of large size, is not tortuous like the artery and receives the following additional branches: vasa brevia, left gastro-epiploic, pancreatic branches, pancreatico-duodenal and inferior mesenteric.

The Gastric veins are two in number. The smaller (the pyloric) runs along the lesser curvature of the stomach toward the pyloric end, receives branches from the pylorus and duodenum, and terminates in the vena portæ; the larger (the coronary) begins near the pylorus, runs along the lesser curvature of the stomach toward the esophageal opening, and curves downward and backward between the folds of the lesser omentum to end in the vena portæ.

Fig. 1.

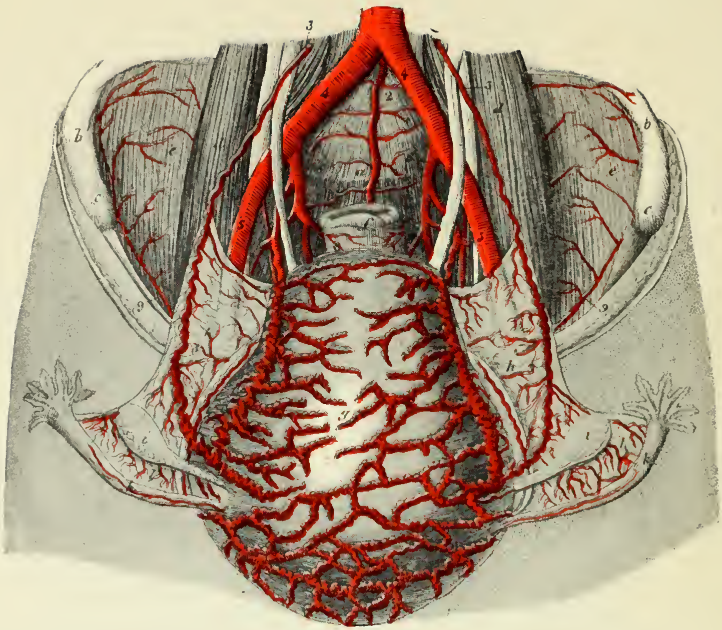


Fig. 2.

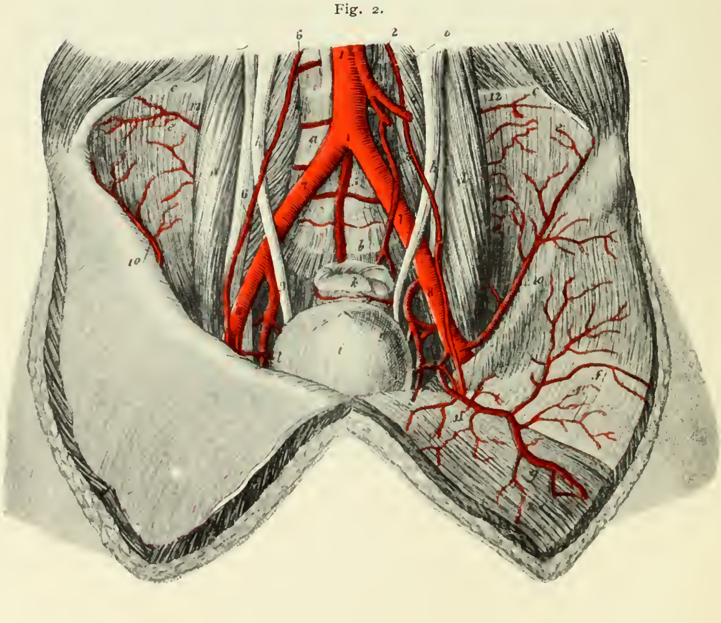


PLATE XXXVII.

BLOOD VESSELS OF PERINEAL REGIONS (MALE AND FEMALE).

Fig. 1.—Arteries of Pelvis and Internal Genital Organs in Female Subject.

a. Sacrum.
b. Crest of ilium.
c. Spina ilii anterior superior.
d. Psoas magnus muscle.
e. Internal iliac muscle.
f. Rectum.
g. Uterus.
h. Lateral ligament of uterus.
i. Ovum, with ovarian ligament.
k. Fallopian tubes.

Arteries.

1. Descending abdominal aorta.
2. Sacra media.
3. Internal spermatic.
4. Internal iliac.
5. External iliac.
6. Internal iliac.
7. Uterine.
8. Middle hemorrhoidal.
9. Circumflex iliac.

Fig. 2.—Arteries of Pelvis in Male Subject.

a. Last lumbar vertebra.
b. Sacrum.
c. Crest of ilium.

Muscles.

d. Psoas magnus.
e. Internal iliac.
f. Transverse abdominal.
g. Rectus abdominis.
h. Ureter.
i. Bladder.
k. Rectum.
l. Vas deferens.

Arteries.

1. Descending abdominal aorta.
2. Inferior mesenteric.
3. Internal hemorrhoidal
4. Left colic.
5. Sacra media.
6. Internal spermatic.
7. Common iliac.
8. External iliac.
9. Internal iliac.
10. Circumflex iliac.
11. Inferior epigastric.
12. Ilio-lumbal.

Fig. 1.

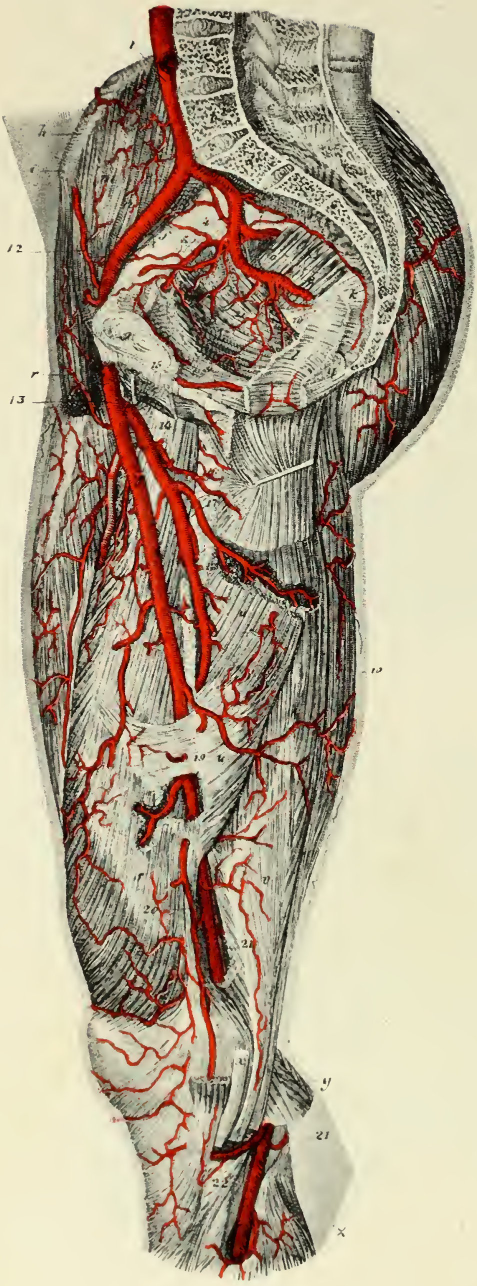


Fig 2.

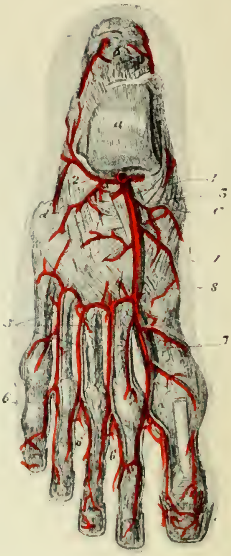


Fig. 3.

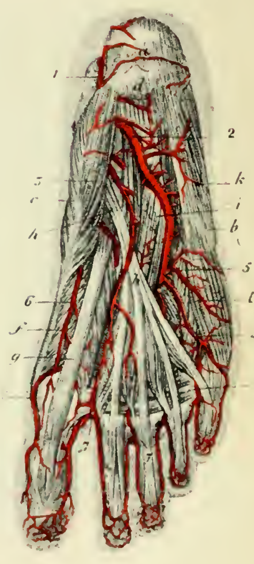


PLATE XXXVIII.

ARTERIES OF PELVIS AND LOWER EXTREMITIES.

Fig. 1.—Arteries on Internal Surface of Pelvis, Thigh and Knee of the Right Extremity.

a. Fourth lumbar vertebra.
b. Fifth lumbar vertebra.
c. Spinal canal.
d. Sacrum.
e. Coccyx.
f. Linea arcuata interna.
g. Symphysis pubis.
h. Crest of ilium.
i. Anterior superior spine of ilium.
k. Lesser sacro-sciatic ligament.
l. Rectum.

Muscles.

m. Internal iliac.
n. Psoas major.
o. Pyriform.
p. Internal obturator.
q. Levator ani.
r. Sartorius.
s. Vastus internus.
t. Rectus femoris.
u. Adductor magnus.
v. Semimembranosus.
w. Semitendinosus.
x. Tendo gracilis.
y. Gastrocnemius (internus).
z. Soleus.

Arteries.

1. Right common iliac.
2. Internal iliac.
3. External iliac.
4. Ilio-lumbal.
5. Obturator.
6. Sacra lateralis.
7. Glutæa superior.
8. Glutæa inferior.
9. Internal pubic.
10. Middle hemorrhoidal.
11. Vesical.
12. Circumflex iliac.
13. Femoral.
14. Profunda femoris.
15. Circumflexa femoris interna.
16. Perforating profunda femoral (1).
17. Perforating profunda femoral (2).
18. Perforating profunda femoral (3).
19. Femoral, in Hunter's canal.
20. Anastomotica magna.
21. Popliteal.
22. Inferior internal articular of knee.

Fig. 2.—Arteries on Dorsal Surface of Right Foot

a. Astragalus.
b. Os calcis.
c. Navicular.
d. Tuber ossis metatarsi (5)

Arteries.

1. Dorsalis pedis.
2. External tarsal.
3. Internal tarsal.
4. Metatarsal.
5. Interosseæ dorsalis metatarsi.
6. Digitales pedis dorsalis.
7. Interosseus dorsal with the external and internal branches to great toe.
8. Communicating branch to deep plantar arch.

Fig. 3.—Plantar Arch of Arteries in Sole of Right Foot.

a. Tuber os calcis.
b. Tuberositas ossis metatarsi (5).
c. Capitulum ossis matatarsi (1).

Muscles.

d. Flexor digitorum pedis communis brevis v. perforatus.
e. Abductor pollicis pedis.
f. Flexor brevis pollicis pedis.
g. Flexor longus pollicis pedis.
h. Flexor digitorum pedis communis longus v. perforans.
i. Accessorius.
k. Abductor digiti pedis (5).
l. Flexor brevis digiti pedis (5).
m. Transversalis pedis.

Arteries.

1. Posterior tibial.
2. External Plantar.
3. Branches of internal plantar.
4. External plantar of toe.
5. Communicating branch of deep plantar arch.
6. Plantaris pollicis pedis.
7. Interosseus plantar.

Fig. 5.

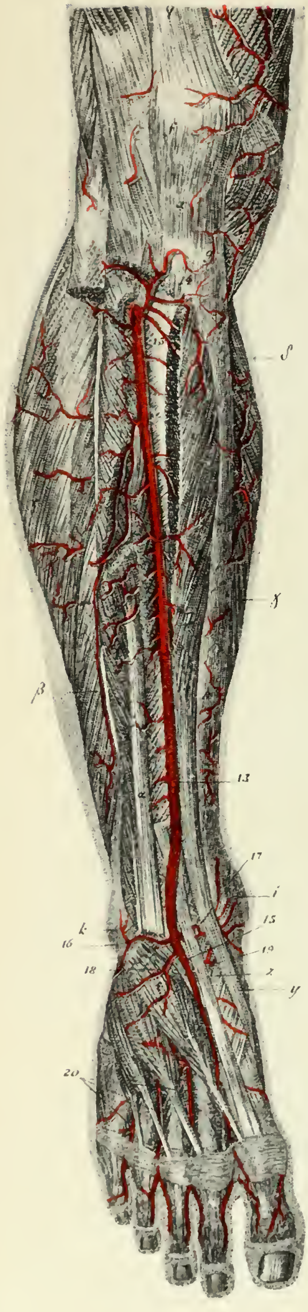


Fig. 4.

Fig. 6.

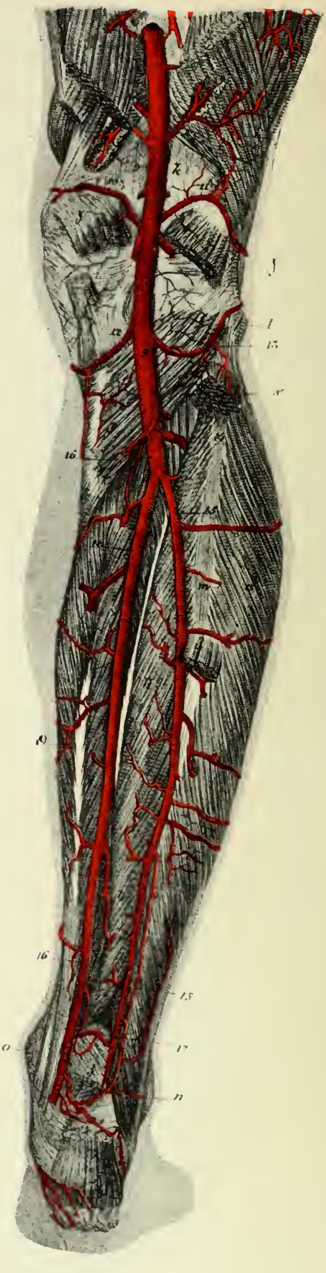


PLATE XXXIX.

ARTERIES OF PELVIS AND LOWER EXTREMITIES—(Continued).

Fig. 4.—Deep Arteries in Sole of Right Foot.

a. Tuber os calcis.

Muscles.

b. Abductor pollicis pedis.
c. Interosseus plantar of foot.
d. Short flexor of toe.

Arteries.

1. Posterior tibial.
2. External plantar.
3. Internal plantar.
4. Tibialis plantaris pollicis pedis.
5. Perforating branches.
6. Deep plantar arch.
7. Interosseus plantar.
8. Digitalis pedis plantares.
9. External plantar of toe.

Fig. 5.—Arteries on Anterior Surface of Right Leg and Foot.

f. Patella.
g. Tuberosity of the tibia.
h. Tibia.
i. Internal malleolus.
k. External malleolus.

Muscles.

q. Tendo communis extensorius.
x. Ligament of patella.
y. Tibialis anticus.
z. Extensor pollicis pedis longus.

α. Extensor digitorum communis longus.
β. Peronæus tertius.
γ. Soleus.
δ. Gastrocnemius.
ε. Extensor pollicis pedis brevis.
ζ. Extensor digitorum communis brevis.

Arteries

13. Anterior tibial.
14. Recurrent tibial.
15. Dorsal of foot.
16. External malleolar.
17. Internal malleolar.
18. External tarsal.
19. Internal tarsal.
20. Interosseæ metatarsi dorsalis.

Fig. 6.—Arteries on Posterior Surface of Right Leg.

k. Popliteal space.
l. Head of fibula.
m. Fibula.
n. External malleolus.
o. Internal malleolus.

Muscles.

y. Short head of biceps femoris.

β. Poplitæus.
γ. Heads of gastrocnemius.
δ. Peronæus longus.
ε. Peronæus brevis.
ζ. Flexor longus pollicis pedis.
η. Tibialis posticus.
ϑ. Flexor digitorum longus.
ι. Tendon of Achillis.
κ. Soleus.

Arteries.

9. Popliteal.
10. Internal superior articular of knee.
11. External superior articular of knee.
12. Internal inferior articular of knee.
13. External inferior articular of knee.
14. Anterior tibial.
15. Peronæal of fibula.
16. Posterior tibial.
17. External posterior malleolar.

Fig. 1.

PLATE XL.

FŒTAL CIRCULATION WITH PLACENTA AND UMBILICAL CORD.

Fig. 1.—Fœtal Organization.

a. Right ventricle of heart.
b. Left ventricle of heart.
c. Left auricle of heart.
d. Origin of aorta.
e. Arch of aorta.
f. Pulmonary artery.
g. Left branch (divided).
h. Left pulmonary veins.
i. Ductus arteriosus.
k. Descending aorta.
l. Superior vena cava.
m. Left innominate vein.
n. Common iliac artery.
o. External iliac artery.
p. Internal iliac artery.
q. Umbilical artery.
r. Umbilicus.
s. Umbilical vein.
t. Fundus of bladder.
u. Urachus.
v. Placenta.
w. Amnion.
x. Chorion.
y. Spongy portion of placenta.
z. Left lobe of liver.

α. Right lobe of liver.
β. Gall bladder.
γ. Umbilical vein.
δ. Portal vein, anastomosing with umbilical vein.
ε. Ductus venosus.
η. Hepatic vein.
ϑ. Inferior vena cava.
ι. Lobus Spigelii.
μ. Kidney.
ν. Supra-renal capsule.

PART FIRST.

THE HUMAN BODY.

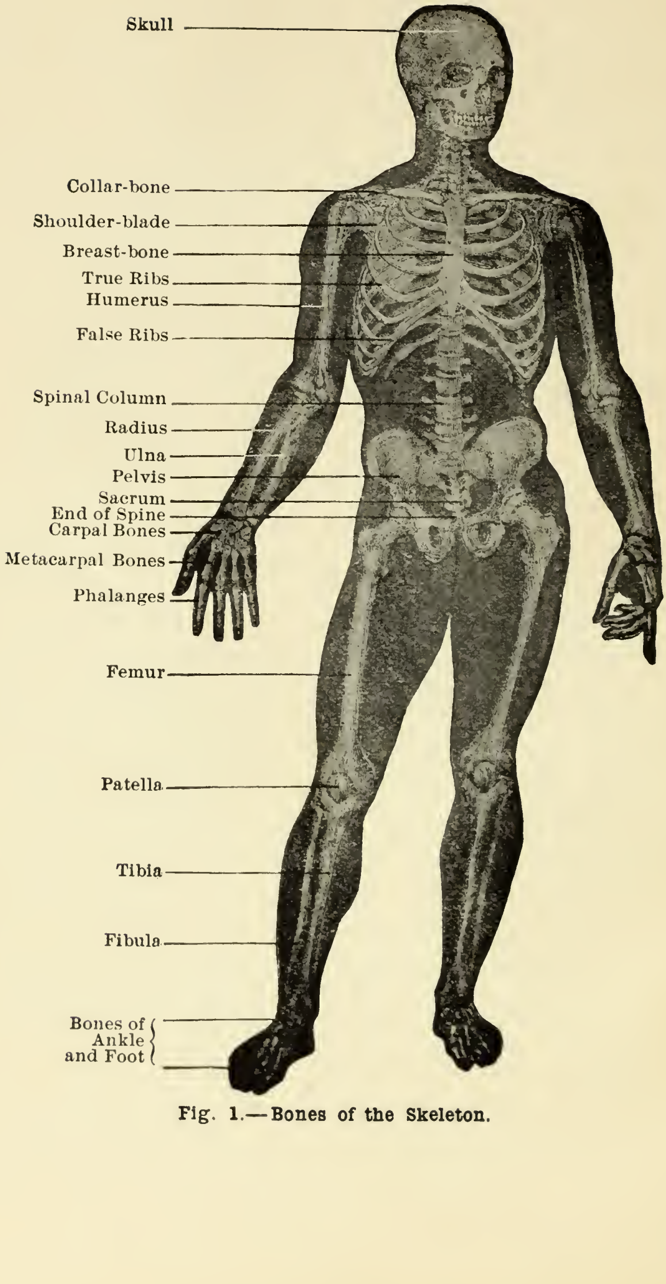


Fig. 1.—Bones of the Skeleton.

ANALYSIS OF THE HUMAN SKELETON.

- The Head (22 bones).
  - 1. Cranium (8 bones).
    - Frontal (forehead).
    - Two Parietal (sides).
    - Two Temporal (temple) bones.
    - Sphenoid (base of skull).
    - Ethmoid (sieve-like bone at root of tongue).
    - Occipital (back and base of skull).
  - 2. Face (14 bones).
    - Two Superior Maxillary (upper jaw).
    - Inferior Maxillary (lower jaw).
    - Two Malar (cheek).
    - Two Lachrymal (in orbit of eye).
    - Two Turbinated (scroll like).
    - Two Nasal (bridge of nose).
    - Vomer (bone between the nostrils).
    - Two Palate.
- The Trunk (54 bones).
  - 1. Spinal column (24 bones).
    - Seven Cervical Vertebræ.
    - Twelve Dorsal Vertebræ.
    - Five Lumbar Vertebræ.
  - 2. Ribs (24 bones).
    - True Ribs.
    - False Ribs.
  - 3. Sternum (breast bone).
  - 4. Hyoides (bone at root of tongue).
  - 5. Pelvis (4 bones).
    - Two Inominata.
    - Sacrum.
    - Coccyx.
- The Limbs (124 bones).
  - 1. Upper Limbs (64 bones).
    - Shoulder
      - Scapula.
      - Clavicle.
    - Arm
      - Humerus.
      - Ulna and Radius.
    - Hand
      - Eight Carpal Bones.
      - Five Metacarpal Bones
      - Phalanges (14 bones).
  - 2. Lower Limbs (60 bones).
    - Leg
      - Femur.
      - Patella.
      - Tibia and Fibula.
    - Foot
      - Seven Tarsal Bones.
      - Five Metatarsal Bones
      - Phalanges (14 bones).

CHAPTER I.

OSTEOLOGY.

GENERAL DESCRIPTION OF THE BONES.

The Bones of the Skeleton are about two hundred in number.

Some authorities omit the 6 small bones of the ear, which makes the number exactly 200. Counting these and the 8 small sesamoid bones at the root of the thumb and great toe, as other authorities do, makes the number 214. The teeth are never enumerated among the bones.

The bones are placed in such a position as to bestow individual character upon the body, afford points of connection to the numerous muscles, and give firmness and strength to the entire fabric. In the extremities they are hollow cylinders, and by their formation and structure are admirably calculated to support weight and resist violence. Bone has been found by experiment to possess twice the resisting property of oak.

"Cut a sheet of foolscap in two pieces. Roll one half into a compact cylinder, and fold the other into a close, flat strip; support the ends of each and hang weights in the middle until they bend. The superior strength of the roll will astonish one unfamiliar with this mechanical principle. In a rod, the particles break in succession, first those on the outside, and later those in the center. In a tube, the particles are all arranged where they resist the first strain. Iron pillars are therefore cast hollow. Stalks of grass and grain are so light as to bend before a breath of wind, yet are stiff enough to sustain their load of seed."

In the Head and Trunk the bones are flattened and arched for the purpose of protecting cavities and providing

an extensive surface for attachment. In some situations they present projections which serve as levers; in others smooth grooves which act as pulleys for the passage of tendons. By their numerous divisions and mutual apposition, the bones are equally adapted to fulfill every movement of the body, which may tend to its preservation or be conducive to its welfare.

Classification of Bones.—The bones are divided into four classes: long, short, flat and irregular.

The long bones are ninety in number and act as supports, or levers; as in the limbs.

The short bones are thirty in number and are found where strength is required and motion is limited; as in the hands and feet.

The flat bones are forty in number, and protect the viscera by forming walls around them; as in the head, chest, etc.

The irregular bones are forty in number; as in the face, vertebral column, etc.

The Composition of the Bones at maturity is about one part animal, or organic matter, consisting of gelatine, vessels and fat, and about two parts mineral, or inorganic matter, consisting of phosphate and carbonate of lime (62 1-3 per cent.), with fluoride of lime, phosphate of magnesium, sodium and chlorid of sodium (4 1-3 per cent.). The proportion varies with age. In youth it is nearly half and half, while in old age the mineral is greatly in excess. Heat will remove the animal matter and leave the mineral.

Put a bone into a hot fire for a few minutes and when carefully removed it will have the same shape as before, but be much lighter, perfectly white, very brittle, and will easily crumble. The animal or organic part has been burnt out, leaving only the earthy or inorganic part.

Acid will remove the mineral matter and leave the animal.

Immerse a long, slender bone for some time in dilute muriatic acid. The bone will retain its original shape but be lighter in weight, soft and pliable, so that it can be twisted or tied into a knot. The acid has eaten out the earthy part but left unaffected the animal part.

The Structure of Bones.—Bone is composed of an outer compact layer, and an inner cellular or spongy structure. The spongy structure increases in quantity, and becomes more porous at the ends of a long bone, while the compact portion increases near the middle, where strength is needed.

Fresh or Living Bone is moist, pinkish in color, and covered with a tough membrane, called the periosteum (from *peri*, around; *osteon*, a bone), filled with marrow, and lined with a similar membrane, the endosteum (*en* in; *osteon*, a bone).

The Lacunæ.—If a thin transverse section of bone be placed under the microscope, black spots with lines running in all directions are seen. These are cavities called lacunæ, from which radiate small tubes. The lacunæ are arranged in circles around large tubes, called the Haversian canals, which serve as passages for the blood vessels. By means of these canals the blood circulates through the bone tissue, nourishing it.

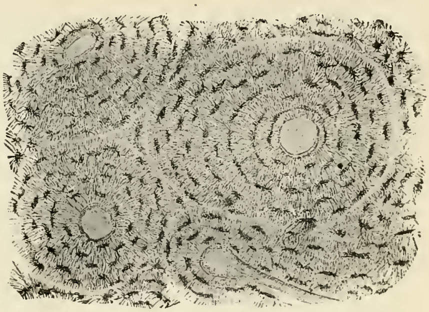


Fig. 2.

A thin slice of bone, highly magnified, showing the lacunæ, the tiny tubes (canaliculi) radiating from them, and four Haversian canals, three seen crosswise and one lengthwise.

Development of Bone.—The bone structure does not reach its full development until about the twenty-fifth year. The skeleton of the body in infancy is composed largely of cartilage, which is a white, glistening

substance commonly known as gristle. As age advances earthy matter is deposited in the cartilage, the bone gradually becoming harder and growing proportionately to other parts of the body. The bones in childhood being tough are not easily fractured, and when broken readily heal again, while those of elderly people are brittle and liable to fracture and do not easily reunite.

The Joints are movable or immovable. The movable joints are covered with a soft, smooth cartilage which fits so perfectly as to be air tight. It is lined with a thin (synovial) membrane, which secretes a viscid fluid not unlike the white of an egg. This fluid lubricates the joints and prevents friction. The body is the only self-oiling machine in existence. The immovable joints have no synovial membrane. The bones which form the joint are bound together firmly with strong ligaments (from *ligo,* I join), so as to keep them always in apposition.

Injury and Repair of Bones.—The proper growth and development of the bones is often hindered by disease or injury. Lack of a proper amount of earthy matter makes the bones soft and allows them to be easily bent out of shape, causing deformity.

The Breaking of a Bone is by no means an infrequent occurrence. When broken the blood oozes out of the fractured ends. This soon becomes a watery fluid, which, in the course of a couple of weeks, thickens to a gristly substance, forming a cement which holds the fractured ends in place. In five or six weeks the broken parts will have reunited, bone matter having been gradually deposited about the fracture. This new formation is larger than the adjacent bone, but the extra matter is gradually absorbed, and often no trace of the injury remains.

BONES OF THE HEAD.

The Bones of the Skull and the Face form a cavity for the protection of the brain. They are immovable, except the lower jaw which is hinged at the back, so as to allow the opening and shutting of the mouth.

The Skull Bones are composed, in general, of two compact plates, with a spongy layer (diploe) between. The outer bones are joined together by notched edges, or sutures, similar to what the carpenter terms dovetailing.

The Cranial Cavity thus formed affords a perfect shelter for the brain. It is oval in shape and adapted to resist pressure. It communicates at the base, through the foramen magnum, with the spinal cavity.

BONES OF THE TRUNK.

The Trunk contains the two largest cavities, the chest and abdomen. The principal bones are those of the spine, the ribs and the pelvis, or hips.

The Spinal Column consists of twenty-four bones, called vertibræ (*verto*, to turn), one placed upon another, between which are placed pads of cartilage. A canal is hollowed out of the column for the protection of the spinal cord. There are projections (processes) at the back and sides, which serve as levers for the attachments of muscles and ligaments. The skull articulates with the spine in a peculiar manner. On the top of the upper vertebra (atlas) are two little hollows (faucets) lined with the synovial membrane, which receive the projections on the lower part of the skull, one on either side of the foramen magnum, allowing the head to rock to and fro. The second vertebra (axis) has a peg (odontoid process) which projects through a hole in the atlas, so that when we move the head sidewise, the atlas turns around the peg of the axis. The spinal column serves as a support for the whole body.

The Ribs are twenty-four in number and are arranged in pairs on each side of the chest. They are also attached to the spine at the back. The upper seven pairs are attached by cartilages to the sternum (breastbone); the next three pairs are fastened to each other and to the cartilage above ; and the last two pairs, the floating ribs, are loose. The long, slender and arched ribs give lightness and strength, and the cartilages give elasticity to the chest—properties essential to the protection of the organs within, and to freedom of motion in respiration.

The Innominata (nameless), or hip bones, form the pelvis in front and at the sides and the sacrum and coccyx at the back. The hip bones form the pubic arch and are joined by a seam, termed the symphysis pubis.

The Extremities, or limbs, are connected to the trunk, and are four in number: two upper, joined to the thorax through the intervention of the shoulder; and two lower, connected with the pelvis. The upper pair, comprising the shoulders, arms, and hands, are subservient to tact and prehension ; the lower pair, comprising the legs and feet, to support and locomotion.

BONES OF THE UPPER EXTREMITY.

The Shoulder.—The bones of the shoulder are the clavicle (collar bone) and the scapula (shoulder blade). The clavicle is a long bone shaped like the italic *f*. It articulates at one end with the sternum and at the other with the scapula.

The Scapula is a thin, flat, triangular bone, situated on the top and back of the chest, forming the back part of the shoulder.

The Shoulder Joint.—The humerus, or arm bone, articulates to the shoulder blade by a ball-and-socket joint.

This consists of a cuplike (glenoid) cavity in the scapula, and a rounded head of the humerus to fit it, thus affording a free rotary motion.

The Elbow is formed by the humerus and ulna articulation. The ulna is small at the lower end, while the radius, or large bone of the forearm, on the contrary, is small at its upper end, and large at its lower end, where it forms the wrist joint.

The Carpus, or wrist, consists of two rows of short bones, one row of which articulates with the radius, forming the wrist joint, and the other with the metacarpal bones.

The Hand.—The metacarpal bones, or bones of the palm, support the fingers and thumb. Each finger has three bones, while the thumb has two. The first is articulated with the metacarpal bone, the second to the first, and the third to the second. The bones of the fingers and thumb are called the phalanges.

BONES OF THE LOWER EXTREMITY.

The Femur, or thigh bone, is the longest, largest, and strongest bone in the skeleton. It articulates with the hip bone by a ball-and-socket joint. The acetabulum, a cup-shaped depression, receives the head of the femur, forming a very strong joint.

The Knee Joint is strengthened and protected by the patella or kneecap, the largest sesamoid bone, which is firmly fastened over the joint in the tendon of the quadriceps muscle.

The Tibia, or shin bone, the largest bone of the leg, articulates with the femur, forming the knee joint; with the foot, forming the ankle joint; and with the fibula, the small outside bone of the leg.

The Foot, in general arrangement, is very similar to that of the hand. The several parts of the foot are the

tarsus, the metatarsus, and the phalanges. The numerous bones are joined together with cartilages, giving elasticity to the foot in walking.

A study of Plates I to VI will give a very good idea of the appearance and relative sizes of the bones.

Sesamoid Bones are small osseous masses, developed in tendons, which exert a degree of force upon the parts over which they glide. They are enveloped entirely by the fibrous tissue of the tendon in which they exist, except on the side that articulates with the part over which they glide.

Wormian Bones are sometimes found in the cranial sutures, but are not constant in number or size.

Articulations are divided into three classes: (1) synarthrosis, immovable; (2) amphiarthrosis, synchondrosis or symphysis, having limited motion; (3) diarthrosis, having free motion. The latter is divided into gliding joints, ball-and-socket joints, and hinge joints. The varieties of motion in joints are: flexion, extension, adduction, abduction, rotation, circumduction, and gliding movements.

The Structures that enter the formation of joints are, the articular lamellar of bone, cartilage, fibro-cartilage, synovial membrane, and ligaments. Articular lamella of bone differs from ordinary bone tissue in being more dense, containing no Haversian canals, nor canaliculi, and having large lacunæ. Cartilage is temporary or permanent. The first forms the original framework of the skeleton, and becomes ossified. Permanent cartilage is not prone to ossification, and is divided into three varieties: (1) articular, covering the ends of bones in joints; (2) costal, forming part of the skeleton; (3) reticular, arranged in lamellæ, or plates, to maintain the shape of certain parts. Fibro-cartilage is (1) inter-articular, separating the bones of a joint; (2) connecting, binding bones together; (3) circumferential,

deepening cavities; (4) stratiform, lining grooves. Synovial membranes secrete the synovia, a viscid, glairy fluid, resembling the serous membranes in structure. They are (1) articular, lubricating joints; (2) bursal, forming closed sacks; (3) vaginal, ensheathing tendons.

THE LIGAMENTS.

The Ligaments, which bind the bones together at the joints, are strong bands of a smooth, silvery white, fibrous tissue. It is solid and inelastic, softer than cartilage, but harder than membrane. The bond formed is so strong that the bones are sometimes broken without injury to the fastenings. There are a vast number of ligaments in the human body, various in form and office, and each with its own special name. For shape, size, office, and names of ligaments, see Plates VII to IX.

CHAPTER II.

THE MUSCLES.

The Muscles are the moving organs of the animal frame. They constitute by their size and number the great bulk of the body, upon which they bestow form and symmetry. In the limbs they are situated around the bones, which they invest and defend, while they form to some of the joints a principal protection. In the trunk they are spread out to enclose cavities, and constitute a defensive wall, capable of yielding to internal pressure, and again returning to its original position. Their color presents the deep red that is characteristic of flesh, and their form is variously modified to execute the varied range of movements which they are required to effect. Muscle is composed of a number of parallel fibers placed side by side, and supported and held together by a delicate web of areolar tissue, so that if it were possible to remove the muscular substance, we should have remaining a beautiful reticular framework, possessing the exact form and size of the muscle without its color and solidity.

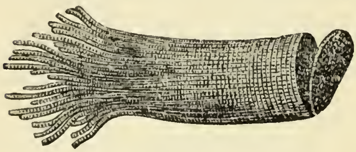


Fig. 3.

Microscopic view of a Muscle, showing at one end, the fibrillæ; and, at the other, the disks, or cells, of the fiber.

Wash out the color from a lean piece of beef and the fine fibers of which the meat is composed are easily detected. In boiling corned beef the fibers often separate, owing to the delicate tissue which bound them together being dissolved. The microscope shows that

these fibers are in turn made up of minute filaments (*fibrils*), and that each fibril is composed of small cells arranged like a string of beads. This gives the muscle its striped, or striated, appearance. The cells are filled with a fluid or semi-fluid mass of living (protoplasmic) matter.

Number of Muscles.—There are about five hundred muscles in the human body, each having a special use, and all working together harmoniously and perfectly. Many of the external muscles can be seen and traced on Plates X to XV, but beneath these are still larger numbers, many being quite tiny and delicate, too small to be seen with the unaided eye.

Contractility is a peculiar and wonderful property possessed by muscles, resulting from the elastic nature of the muscular tissues. Contraction is effected by an effort of the will, by cold, certain kinds of irritation, a sharp blow, etc. When a muscle contracts it becomes shorter and thicker, drawing the ends nearer together. Bending the elbow nicely illustrates this action. The biceps muscle on the front of the upper arm can be seen and felt to become shorter and thicker as it contracts. Contractility does not always cease at death, as a contraction of the muscles is frequently noticed in certain cold-blooded animals long after the head has been severed from the body.

The Tendons are white, glistening cords, or bands, formed almost entirely of white fibrous tissue, have few vessels and no nerves, and serve to connect the muscles with the structure on which they act. This union is so firm that, under extreme violence, the bone itself rather breaks than permits of the separation of the tendon from its attachment. The muscular fibers spring from the sides of the tendon, allowing more of them to act upon the bone than if directly attached. This mode of attachment gives strength and elegance. In the broad muscles the tendon

is spread so as to form an expansion, called aponeurosis.

Fasciæ (*fascia*, a bandage) are laminæ of variable thickness which invest the softer structures. The superficial fasciæ are composed of fibro-areolar tissue, and are found beneath the skin almost over the whole body. The deep fasciæ are of aponeurotic structure, dense, inelastic, and fibrous, ensheathing muscles and affording attachment to some of them, ensheathing also the vessels and nerves, and binding down the whole into a shapely mass.

Arrangement of Muscles.—The muscles are generally arranged in pairs, one expanding as the other contracts, giving the bone to which they are attached its backward and forward, or other, movements.

Grasp the arm tightly above the elbow and bend the forearm, when the muscle on the inside can be felt as it swells and becomes hard and prominent, while the outside (triceps) muscle relaxes. Straighten the arm and the conditions are reversed. When the muscles of one side of the face become palsied, those on the opposite side draw the mouth that way.

Modification of Muscles.—Muscles present various modifications in the arrangement of their fibers in relation to their tendinous structure. Sometimes they are completely longitudinal, and terminate at each extremity in tendon, the entire muscle being fusiform in its shape; in other situations, they are dispersed like the rays of a fan, converging to a tendinous point, as the temporal, pectoral, gluteal, etc., and constitute a radial muscle. Again they are penniform, converging like the plumes of a pen to one side of the tendon, which runs the whole length of a muscle, as in the peronei; or bipenniform, converging to both sides of the tendon. In other muscles the fibers pass obliquely from the surface spread out on one side (of a tendinous expansion), to that of another extended on the opposite

side as in the semimembranous; or they are composed of penniform, or bipenniform, fasciculi, as in the deltoid, and constitute a compound muscle.

Kinds of Muscles.—There are two classes of muscles, voluntary and involuntary. The voluntary muscles are those capable of being put in motion by the will, and are composed of reddish fibers. Each one is intended to aid in some movement of the body. All muscles lying on the outside of the skeleton are voluntary. Involuntary muscles, on the other hand, are not capable of being put into action by the will, and are composed of paler fibers, which differ also in shape. Involuntary muscular tissue enters into the formation of the internal organs, as the stomach, intestines, etc. The heart is an involuntary muscle, but its fiber is similar in appearance and structure to those of the voluntary type. The muscles which move the arms, legs, and head are under the control of the will, while the heart beats on day and night. The eyelid combines both classes of muscles, so that we wink constantly, yet may restrain or accelerate that motion.

Attachment of Muscles.— Muscles are attached to the periosteum and perichondrium of bone and cartilage, to the subcutaneous areolar tissue, and to ligaments. The more fixed extremity of a muscle is called the origin, and the more movable, the insertion. The muscles may be arranged in conformity with the general divisions of the body, into those of the head and face, of the neck, of the trunk, of the upper extremities, and of the lower extremities. It is not necessary in a work of this kind to describe all of the muscles—only a few that serve as guides to the principal arteries and veins and the diaphragm.

The Sterno-cleido-mastoid arises by two heads from the sternum and the inner third of the clavicle, and passes upwards and backwards to be inserted into the mastoid

process of the temporal bone and the superior curved line of the occipital bone, behind the ear. The anterior border serves as a guide to the common carotid artery and internal jugular vein.

The Biceps arises by two heads. the long head from the upper margin of the glenoid cavity, the short head from the apex of the coracoid process, and is inserted into the back of the tuberosity of the radius and the fascia of the forearm. The inner border serves as a guide to the brachial artery and basilic vein.

The Sartorius arises from the anterior superior spinous process of the ilium (front part of the hip bone), and half of the notch below it. and passes obliquely downwards and inwards to be inserted into the upper internal surface of the tibia. It is the longest muscle of the body. The internal border serves as a guide to the femoral artery and vein.

These are the guides to the arteries and veins that are usually raised for embalming purposes. Other arteries, as the radial, ulna. tibial, etc., are raised but other guides are used for making the incision.

The Diaphragm (a partition wall) is the thin musculo-fibrous septum, placed obliquely across the trunk, and separating the thorax from the abdomen, forming the floor of the former cavity and the roof of the latter. It is the great muscle of respiration and expulsion. It has three openings—the aortic, esophageal and that of the vena cava—but is impervious to liquids contained in or injected into either cavity.

Wonders of the Muscles.—The action of many muscles is required to keep the human body in an upright position. The center of gravity is so high up, and the joints work so easily, that were it not for the muscular action the skeleton would constantly topple over. But

for the steadying effect of the muscles of the neck the head would be forced to respond to its tendency to fall forward. The strong muscles of the back restrain the hips' natural, forward incline, while the muscles of the calf counteract the pulling forward of the great muscles of the thigh, acting over the kneecap. So it is with other sets of muscles, all acting so perfectly that they are unthought of until science calls attention to them.

Muscular Sense is useful in many ways: The sensation of weight is felt in lifting an object. Cultivation of this sense enables one to form a very precise estimate of the weight of a body by simply lifting it. Walking is a perilous performance which constant practice alone has made safe. Some authorities define walking as perpetual falling with constant self-recovery. In running we simply incline our bodies more and fall faster.

Development of the Muscles.—Proper exercise develops and improves the muscles, while violent, unguarded exercise is injurious. A muscle remaining entirely idle loses the power to take up the nourishment provided, becomes soft and weak, growing constantly smaller, and finally the muscular tissues almost wholly disappear. Exercise increases the flow of blood to the muscles, promoting their nourishment and stimulating their growth. The large, hard and strong muscles of men engaged in manual labor contrasted with the thin and flabby muscles of professional men who are unaccustomed to exercise, clearly show the effects of exercise. Exercise is essential to the health of the whole body, increasing the circulation and power of breathing, and stimulating every part of the body to a healthy growth. To obtain the best advantage exercise should be regular and systematic, and taken in proper amounts.

CHAPTER III.

THE ABSORBENTS.

THE SKIN.

The Skin, or integument (*intego*, to cover), is the tough, thin, elastic investment, with which the entire surface of the body is covered. Its perfect elasticity adapts it to every motion of the body. The skin surface of an adult is about sixteen square feet. It is not a mere covering, being an active and important excretory and absorbing organ. Like the joints it is self-oiling, but for a different reason, namely, to preserve its smoothness and delicacy. It also replaces itself as fast as worn out. The skin varies in thickness in different parts of the body, being quite thick when exposed to friction and pressure, as on the soles of the feet and palms of the hands. At the openings of the body, as the mouth, it becomes merged into the mucous membrane. The true skin consists of fibro-areolar tissue, and merges with the fatty tissues beneath it in which layer is found an abundant supply of blood vessels, nerves, lymphatics and glands.

Structure of the Skin.—The skin consists of two layers, outer and inner. The latter is called derma, cutis, or true skin, all meaning the same thing. The outer layer is variously called the cuticle (*cuticula*, little skin), epidermis (*epi*, upon ; *derma*, skin), and scarfskin. This layer is what is commonly styled the skin and the part raised by a

blister. It neither bleeds nor suffers from heat or cold, and possesses neither blood vessels nor nerves. The cuticle is composed entirely of small flat cells, or scales, which are constantly being shed from the surface in the form of scurf, dandruff, etc., but are constantly being renewed from the cutis below. The number of these cells is almost beyond conception. Harting estimated the number in one square inch, counting only a single layer, at over a billion, each complete in itself.

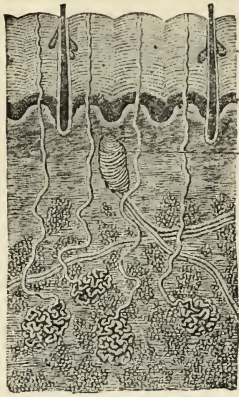


Fig. 4.—Section of Skin Magnified

Rete Mucosum.—On the lower side of the cuticle is a soft layer called the rete mucosum made up of small grains and forming a pigment, which gives to the skin its color and complexion. This matter varies in color, being in the negro almost black, and in the European various shades from the most pronounced brunette to the lightest blonde.

In the purest complexion there is some of the pigment. The skin has a powerful effect upon the coloring matter. Thus, exposure readily tans, while the African living for a time in the forest, or secluded from the sun, loses much of his normal blackness.

"Skin Slip."—The rete mucosum softens quickly by decomposition after death, and often allows the cuticle to slip or become detached, as in dropsy. This is known as skin slip.

Uses of the Skin.—As an excretory organ the skin removes certain waste material from the body. This

process of elimination is produced by the perspiration, or sweat. This office of the skin is a very important one. If the skin were to be covered with a coat of varnish, or other impervious covering, thus preventing sweating, death would soon result. The amount of sweat secreted in a day averages about two pints, varying according to weather, amount of exercise, etc. The sudoriferous, or sweat, glands are small tubes, opening in the outside of the skin and coiled up just below the true skin. They cover every portion of the skin, being numerous and important in their office, secreting the perspiration. The skin serves also as an organ of sensation, the nerves conveying the sense of touch, pain and temperature being situated in it. It assists in the respiratory process, slightly absorbing oxygen, and giving off carbonic acid gas. The skin likewise has an absorptive power by which certain substances are carried into the system.

The Hair is but a modified form of the cuticle, and exists on nearly the whole surface of the body, varying in length and size. It forms a protection from heat and cold, and shields the head from blows. The roots of the hairs are imbedded in small openings in the skin, called hair follicles, these follicles being from one-twelfth to one-fourth of an inch in depth. The outside of a hair is compact and hard, consisting of a layer of colorless scales which overlie one another like shingles on a roof. The interior is porous and conveys the liquids by which it is nourished. It also contains pigmentary matter, upon which the color of the hair depends. The hair and scalp are kept soft and pliable by the oily secretion of the small glands, which open into the hair follicles, called sebaceous glands. That portion of a hair outside the skin is called the shaft. Each hair grows from a tiny bulb (*papilla*), which is an elevation of the cutis at the bottom

of a little hollow of the skin. The hair is produced, like the cuticle, from the surface of this bulb, by the constant formation of new cells at the bottom. When the hair is pulled out, this bulb, if uninjured, will produce a new hair, but once destroyed it will never grow again. Hair grows at the rate of five to seven inches a year.

The popular idea that hair grows after death is due to the shrinking of the skin, allowing the portion of hair below the surface to project. This is especially noticeable in the beard.

When the color once changes it cannot be restored. The hair has been known to whiten in a single night.

Hairs are destitute of feeling, but nerves are found in the hollows in which the hair is rooted, causing pain when the hair is pulled. Thus insensible, though they are, hairs become wonderfully delicate instruments for conveying an impression of even the slightest touch.

The hair, next to the teeth and bones, is the least destructible part of the body, and its color is often preserved for many years after other portions of the body have decayed.

The Nails begin near the tips of the fingers and toes, and consist of two parts, a root and a body. The latter is the part exposed to view, being about four times the length of the root. They protect the tender fingers and toes, and give the power to grasp firmly and pick up easily any desired object. The nail is firmly set in a groove (*matrix*) in the cuticle, from which it grows at the root in length and from beneath in thickness. So long as the matrix at the root is uninjured, the nail will be reproduced after an accident.

Like the hair the nail is a mere modified form of the epidermis, its horny appearance and feeling being due to the fact that the scales or plates of which it is composed are much harder and more closely packed. It is thrown into ridges which run parallel to each other except at the back part where they radiate from the center of the root.

The whitish semi-circular portion near the root, called the lunula (*lunula*, little moon), owes its different color to the fact that its ridges contain fewer blood vessels and therefore less blood.

The thumb nail will grow from the root to its free end in about five months, and the nail of the great toe in twenty months.

THE LYMPHATIC SYSTEM.

The Lymphatics are very delicate, transparent, nerveless vessels which exist beneath the skin and in all the mucuous membranes. Thus they permeate nearly every portion of the body, being closely interlocked with the blood capillaries. The parts of the body free from them are the brain, spinal cord, eyeball, cartilage, tendons, membranes of the ovum, placenta, umbilical cord, nails, cuticle, hair, and bone. They are formed of three coats, like arteries and veins, and are nourished by nutrient vessels. Like the veins, the lymphatics are provided with valves which permit the matter which they convey to flow only one way. Their economy in the human system seems to be to gather up portions of waste matter capable of further use, emptying it, now known as lymph, into the veins, whence it is conveyed to the heart.

The Lacteals, or chyliferous vessels, are small lymphatics, which have their origin in the mucous membrane lining the small intestine. Through them the greater part of the digested food is absorbed from the small intestine and transferred to the circulatory system. Projecting from the lining membrane of the small intestine are vast numbers of delicate, hair-like projections about a third of an inch long, called villi. In each villus are small blood vessels and lacteals. The villi dip into the digested and liquified food substance, taking it up into the lacteals, where it becomes a milky-white substance and is called chyle.

The Lymphatic Glands are small, hard, pinkish bodies, varying in size from a pinhead to an almond, placed along the course of these absorbent vessels. They are found principally in the mesentery, along the great blood vessels, in the popliteal space, groin, mediastinum, neck, axilla, and front of the elbow. The lymphatic vessels pass through these glands. They receive their names from the

region in which they are situated, as the mediastinal, axilla, etc. In these glands are formed corpuscles resembling the white corpuscles cf the blood, which are taken up by the stream of lymph as it flows past.

The Thoracic Duct is a tube or canal which commences in the receptaculum chyli, in front of the second lumbar vertebra, passes through the aortic opening in the diaphragm, ascending to the left subclavian vein at its junction with the internal jugular into which it empties. It is the channel for the lymph and chyle from the whole body except the right side of the body above and including the convex surface of the liver. Its average length in adults is from fifteen to eighteen inches, and its diameter is about that of a goose quill. It has three coats and is provided with valves.

The Lymphatic Duct is about an inch in length, terminating in the right subclavian vein at its junction with the internal jugular, and draining the lymphatics of those parts that are not connected with the thoracic duct.

The Lymph is an alkaline fluid of a thin, colorless, or yellowish appearance. It closely resembles, in appearance and composition, blood deprived of its red corpuscles and diluted with water. This is the fluid which flows through the lymphatic system.

VISCERAL ANATOMY.

Visceral anatomy treats of the organs contained in the three great cavities of the body, the cranium, the thorax and the abdomen, with their appendages. These organs and appendages are called the viscera, or visceral organs; and those of any cavity are called the viscera of that cavity. The chapters immediately following are devoted, in the main, to the consideration of visceral anatomy.

CHAPTER IV.

THE NERVOUS SYSTEM.

The Nervous System includes the brain, the spinal chord, and the nerves. It is also divided into the cerebro-spinal and sympathetic systems. Although distinct from all other systems of the body, the nervous system unites the various parts and organs into one complete organic whole. It is the medium through which all impressions upon the mind are received and acted upon. The movements of the body and all the processes of life are regulated by it.

Nervous Tissue is composed of two kinds of matter, white and gray, and consists of two different structures, nerve cells and nerve fibers. The nerve cell is the part that is capable of creating nerve force, while the nerve fiber acts as conductor of this force. The nerve cells form the gray matter of the nervous tissue, and are of a pulp-like substance of about the consistency of blanc-mange. The nerve fibers consist of minute, white, glistening fibers, sometimes as small as one-twenty-five-thousandth part of an inch. Every nerve fiber is connected with a nerve cell.

The Nerves are white, glistening cords made up of bundles of nerve fibers, and penetrate every part of the body. These bundles divide and subdivide as they proceed. They also gather into little masses or nerve centers, called ganglions (*ganglion*, a knot). These nerve centers answer to the offices along a telegraph line where messages are sent and received, while the nerves correspond to the wires that carry the messages. Nerves contain two kinds of nerve fibers, one of which conducts from the nerve centers to the muscles or organs, and the other from the latter to the nerve centers. The first is called sensory nerves and the latter motor nerves.

If you place a finger on a hot stove the sensation of pain travels to the nerve center through the sensory nerves. A peculiar force is generated in the nerve center which is conducted through the motor nerves to the muscle which controls the finger, causing it to contract and thus be removed from contact with the hot surface of the stove.

Nerve Current.—This passing of the sensation to the nerve center and of force back to the muscle constitutes what is called the nerve current. This current travels at about the rate of one hundred and ten feet a second, being much slower than an electric current. About one twentieth of a second is required for a sensation to pass from the foot to the brain, and an equal time is required for the force generated to travel back.

Nerve Sensations.—Hearing, feeling, tasting, seeing, and smelling are all different kinds of sensations, each with its special nerve centers which preside over it. There are also several varieties of motor nerves, some coming from centers which preside over the heart and stomach, others over muscles, etc. Certain motor nerves, called vasomotor nerves, are distributed to the walls of the blood vessels and control the circulation by regulating the size of the blood vessels, causing them to dilate or contract according to the amount of blood needed.

The Sympathetic System consists of nerves and nerve centers, or ganglions. There are two chains of ganglions, one on each side of the spinal column, within the body, running the whole length and extending into the chest and abdomen. There are thirty pairs of these ganglions. The sympathetic system of nerves supplies the involuntary muscular tissue, governs all acts of secretion, equalizes the circulation, and controlsthe nutrition of the body. Nerves from the ganglions are distributed to the mucous membranes and the organs concerned in nutrition—the stomach, liver, intestines, etc. The vasomotor nerves belong to this system. Thus all the organs of the body are bound together with cords of sympathy, so that if one suffers all suffer with it.

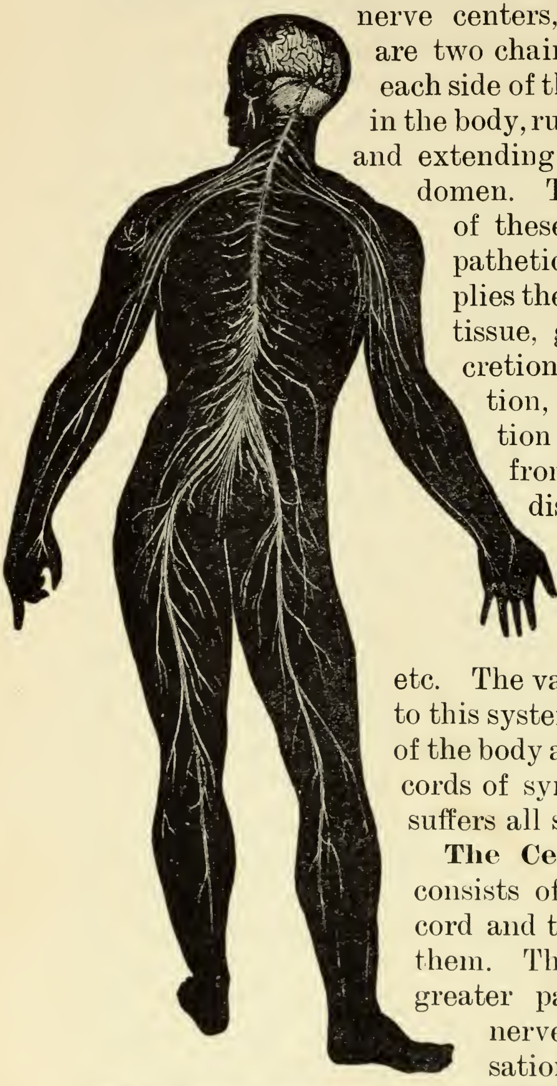


Fig. 5.—Cerebro-Spinal Nerve System.

The Cerebro-spinal System consists of the brain and spinal cord and the nerves coming from them. This system supplies the greater part of the body with nerves. It presides over sensation, special senses, voluntary motion, intellect, and all movements which characterize different individuals,

THE BRAIN.

The Brain is the seat of the mind and it is the functions which the brain performs that distinguishes man from other animals. Man becomes a conscious, intelligent, responsible being through the action of the brain. The average brain weighs about forty-nine and a half ounces in the adult male and forty-four ounces in the female. It is egg-shaped, soft, and yielding, closely filling the skull cavity. It is surrounded by a delicate double membrane, called the arachnoid, forming a closed sac, and filled, as are also the brain spaces, with a watery liquid. Within the membrane, still more closely investing the brain, is a fine vascular membrane, called the pia mater, which dips down between the convolutions and laminæ and is prolonged into the interior, forming the velum interpositum and choroid plexuses of the fourth ventricle. This tissue receives its blood supply from the internal carotid and vertebral arteries, and so copiously does it bathe the adjacent parts that it is said to use one-fifth of the entire circulation of the body. It is plentifully supplied with lymphatics and nerves. The outermost envelope of the brain is the dura mater, a dense, tough, glistening, fibrous membrane, which lines the interior of the brain case, as well as the spinal column. It separates the various parts of the organs by strong partitions.

Ganglions.—The brain is composed of a number of nerve centers, or ganglions, which are connected with one another and the motor and the sensory nerves of the system. It consists of both white and gray matter, and is divided into three portions, cerebrum, cerebellum, and medulla oblongata.

The Cerebrum (the brain) occupies the front and upper part of the cavity of the cranium, and comprises about seven-eights of the entire weight of the brain. It is divided

into two lateral halves, or hemispheres, right and left, by the great longitudinal fissure, which extends throughout the entire length of the cerebrum, reaching to the base in front and behind, but in the middle it is interrupted by a transverse commissure of white matter, the corpus callosum, which connects the two hemispheres. In this fissure lodges the falx cerebri. Each hemisphere is divided, by fissures on the under surface of the brain, into three lobes, anterior, middle, and posterior. Thus we are provided with two brains, as well as hands, feet, eyes, and ears, and one hemisphere has been known to be destroyed in large part without particular injury to the mental powers. The cerebrum is the center of intelligence and thought, and is a mass of white fibers with cells of gray matter on the outside, or lodged here and there in ganglion. The surface is not smooth, except in infancy, but is arranged in large convolutions and sulci, which arrangement very largely increases the surface for gray matter. This surface has been estimated in some cases to measure as much as six hundred and seventy square inches. Depth and intricacy of these convolutions are characteristic of high mental power. Persons of weak mind are oftentimes said to be lacking in gray matter, while brainy persons are said to possess it in large quantities. When the cerebrum becomes seriously injured or diseased the person is often unable to converse intelligently from an inability to remember words and lack of force to articulate them.

The Cerebellum (a small brain) is situated beneath the posterior lobes of the cerebrum, in the inferior occipital fossæ. It is connected by the crura-connecting bands to the rest of the brain, two to the cerebrum, two to the medulla oblongata, and two blending together in front, forming the pons Varolii. It is about the size of a small fist and weighs about five ounces. In structure it is similar to the

cerebrum, being divided into hemispheres, but unlike that portion has parallel ridges, which, letting the gray matter down deep into the white matter within, gives it a peculiar appearance, called the arbor vitæ, or tree of life. This part of the brain is the center for the control of the voluntary muscles, particularly those of locomotion. If it is injured or diseased the power of locomotion is greatly hindered, the muscles not acting together as they should. The falx cerebelli projects between the lateral lobes of the cerebellum.

The Medulla Oblongata (*medulla*, marrow; *oblongus*, rather long) is the upper enlarged part of the spinal cord extending from the upper border of the atlas to the pons Varolii, and connects the spinal chord with the various ganglions of the brain. Its anterior surface rests on the basilar groove of the occipital bone, while its posterior surface forms the floor of the fourth ventricle. It is about an inch and a quarter in length and an inch wide, and is composed of a mass of white matter, within which is imbedded a collection of gray matter or nerve cells. By connecting the spinal chord with the brain, it serves to conduct the sensation and motor stimulus to and from the brain. Probably its most important function is its entire control over the acts of respiration, and if it is injured or destroyed, breathing ceases and death results. Within the medulla oblongata is also supposed to lie the centers of the vasomotor and cardiac nerves, and nerves of phonation, deglutition, mastication, and expression.

The Spinal Cord is the cylindrical elongated part of the cerebro-spinal axis, which is contained in the spinal canal. Its length is usually about sixteen or seventeen inches. It commences at the upper border of the axis and terminates at the lower border of the first lumbar vertebra in the cauda equina. It has two enlargements,

one in the cervical region, and one in the lumbar. It is composed of gray matter internally and white matter externally. It gives out thirty-one pairs of nerves—eight cervical, twelve dorsal, five lumbar, five sacral, and one coccygeal—which divide and subdivide, going to all parts of the trunk and limbs. Each nerve arises by two roots, the anterior being the motory, and the posterior, the sensory root. These roots soon unite into one sheath though they preserve their special functions.

The Cranial Nerves, consisting of twelve pairs, arise from the lower part of the brain and medulla oblongata. They are as follows:—

1. Olfactory, nerves of smell.

2. Optic, nerves of vision.

3. Motor Oculi,
4. Pathetic, } Eye moving nerves.
6. Abducens,

5. Trigeminus (trifacial), nerves of the face, which divide into three branches, going respectively to the upper part of the face, eyes and nose; to the upper jaw and teeth; and to the lower jaw and mouth, the latter branch becoming the nerve of taste.

7. Facial, nerves of expression.

8. Auditory, nerves of hearing.

9. Glossopharyngeal, nerves of the pharynx, tonsils, etc.

10. Pneumogastric, nerves of the larynx, lungs, liver, stomach and heart (in part).

11. Accessory, nerves regulating the vocal movements of the larynx.

12. Hypoglossal, nerves giving motion to the tongue.

CHAPTER V.

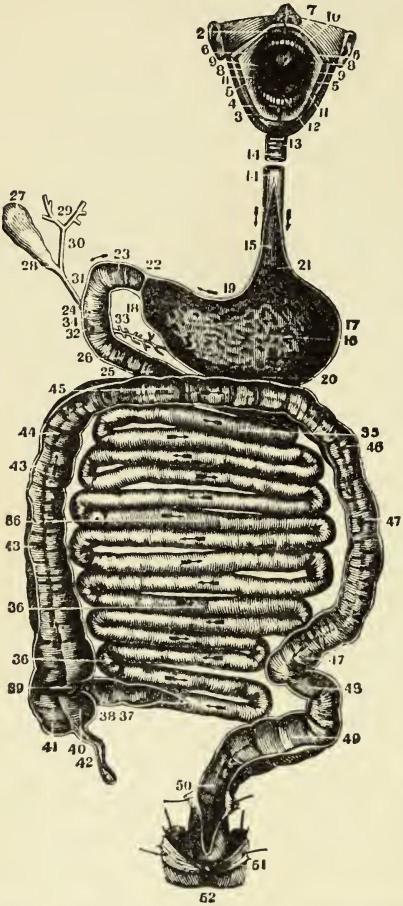
THE DIGESTIVE ORGANS.

The Organs of Digestion consist of the alimentary canal and accessory organs. All food, before it is in a condition to afford nourishment to the tissues, must undergo a certain process, called digestion. It is while passing through these digestive organs that digestion takes place.

The Alimentary Canal, the chief organ of digestion, is a musculo-membranous tube about twenty-five to thirty feet in length, extending from the mouth to the anus, and lined throughout with mucous membrane. It is divided into different parts, each with its distinctive name and duties. These are the mouth, pharynx, esophagus, stomach, small intestine and large intestine. The first three lie above the diaphragm, and the rest below it. The accessory organs are the teeth, salivary glands, liver, pancreas and spleen.

The Mouth, placed at the commencement of the alimentary canal, is an oval-shaped cavity formed by the lips, cheeks, jaws, palate and tongue, in which the mastication of the food takes place. It opens posteriorly into the pharynx by the fauces and contains the tongue, teeth, hard palate, soft palate, uvula, anterior and posterior pillars of the fauces, tonsils and the openings of Steno's and Wharton's ducts and the ducts of Rivinus.

The Salivary Glands are the parotid, lying below and in front of the external ear, the submaxillary and sub-lingual glands, lying in the corresponding fossæ on the



1. Mouth.
2. Hard palate.
3. Lower jaw.
4. Teeth.

5, 5, 6, 6. Mucous membrane.
7. Roof of mouth.
8, 8. Soft palate.
9, 9. Pharynx.
10. Uvula.
11, 11. Tongue.
12. Floor of mouth.
13. Trachea.
14, 14, 15. Esophagus.
16. Stomach.
17. Cardiac end.
18. Pyloric end.
19. Lesser curvature.
20. Greater curvature.
21. Cardiac orifice.
22. Pyloric valve.
23. Beginning of duodenum.
24. Descending duodenum.
25. Ending of duodenum.
26. Transverse duodenum.
27. Gall bladder.
28. Cystic duct.
29, 30. Hepatic duct.
31. Choledoch duct.
32. Pancreatic opening.
33. Pancreatic duct.
34. Choledoch opening.
35. Jejunum.
36, 36, 36. Ilium.
37, 38. Ending of ilium.
39. Ilio-cæcal valve.
40, 41. Cæcum.
42. Vermiform appendix.
43, 43, 44. Ascending colon.
45. Transverse colon.
46, 47, 47. Descending colon.
48, 49. Sigmoid flexure.
50. Rectum.
51. Sphyncter muscle.
52. Anus.

Fig. 6.—The Alimentary Canal, a Portion of Esophagus Being Removed.

inner surface of the inferior maxillary bone. All these glands open into the mouth by ducts and are stimulated to action by the presence of food in the mouth, and by the operation of chewing. The fluid secreted by these glands

is called the saliva. It is mixed with the food during the act of mastication and keeps the interior of the mouth moistened. The saliva is of the greatest importance in the proper digestion of the food, moistening and softening the food so that when it enters the stomach the digestive juices there can readily act upon it.

The Tongue is the organ of special sense of taste. It is situated in the floor of the mouth, in the interval between the two lateral portions of the body of the lower jaw. Its base, or root, is directed backwards, and connected with the hyoid bone by numerous muscles, with the epiglottis by three folds of mucous membrane, which form the glosso-epiglottic ligaments, and with the soft palate and pharynx by means of the anterior and posterior pillars of the fauces. Its mucous membrane is reflected over the floor of the mouth to the inner surface of the gums, forming in front a fold, the frænum of the tongue. Papillæ cover nearly the entire surface of the dorsum of the tongue, giving it its characteristic roughness. The arteries are the lingual, submental and ascending pharyngeal.

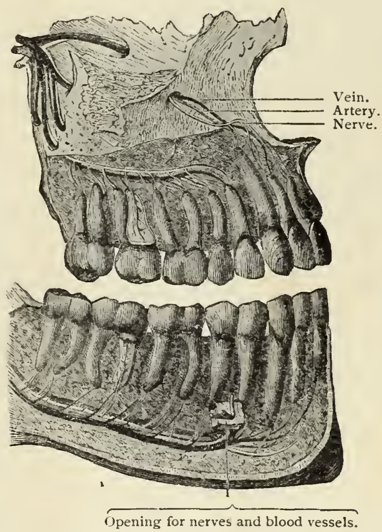


Fig. 7.—The Jaws and Teeth.

The Teeth are a very important factor in the scheme of digestion. Their office is to reduce the food to a proper condition as to fineness, so that it can pass through the pharynx and esophagus into the stomach, and there be easily acted upon. This process is called mastication.

The teeth, of which there are thirty-two in the complete adult set, sixteen in each jaw, consist of crown, neck, and root. The crown is the part above the gums, and is covered with a white, glistening substance, called enamel, which is the hardest substance in the human body. The permanent teeth in each jaw are as follows: four incisors, two canine, four bicuspids and six molars.

The Jaws possess the mechanism for grinding the food. The lower jaw being movable, its muscles bring it against the upper one, giving it also a sidewise motion. The tongue, lips and cheeks assist in mastication by keeping the food mass between the teeth.

The Pharynx, or throat, is a musculo-membranous sac, conical in form, four and a half inches long, with the base upwards and the apex downwards, extending from the basilar process of the occipital bone to the lower border of the cricoid cartilage in front and fifth cervical vertebra behind, where it becomes continuous with the esophagus. It forms that part of the alimentary canal which lies back of the nose, mouth and larynx. It has seven openings communicating with it: the two posterior nares, the two eustachian tubes, the mouth, larynx and esophagus. The arteries that supply the pharynx are superior thyroid, ascending pharyngeal, pterygo-palatine, and descending palatine.

The Esophagus (gullet) is a musculo-membranous canal, about nine inches long, extending from the pharynx, at the lower border of the cricoid cartilage of the larynx, and the fifth cervical vertebra, along the front of the spine, through the posterior mediastinum, passing through the esophageal opening into the abdomen, to the cardiac orifice of the stomach, opposite the ninth dorsal vertebra, where it terminates. It is located in the neck, between the trachea and the vertebral column. Its general direction is vertical. It is the narrowest part of the alimentary canal.

The esophageal arteries are chiefly branches from the thoracic aorta. The veins empty into the vena azygos minor.

The Stomach, the principal organ of digestion, is pyriform in shape, of musculo-membranous structure. It is about twelve inches in length by four inches in average diameter, when moderately full, and will contain on an average from three to five pints of fluid. It is held in position by the lesser omentum, and is situated diagonally across the upper part of the abdomen, in the epigastric and right and left hypochondriac regions, above the transverse colon, and below the liver and diaphragm. The muscular fibers composing the wall of the stomach are arranged in three layers, the first running lengthwise of, the second around, and the other obliquely across, the stomach. When food enters the stomach the lining membrane, which in rest is of a pinkish color, becomes bright red from the increased flow of blood to its blood vessels, and the secretion of gastric juice, the digestive fluid of the stomach, begins. In the healthy adult about fourteen pints of gastric juice is secreted by the peptic glands every twenty-four hours. The muscular fibers of the walls are stimulated to action by the presence of food in the stomach, and, by alternate contractions and expansions, give it a sort of motion which causes the contents to roll about in its interior, thoroughly mixing them with the gastric juice. The digested portion of the food is taken up into the circulation, and the remainder passes through the pyloric orifice into the small intestine where digestion is completed. Stomach digestion requires from one to four hours, according to the condition of the food when it enters.

The Fundus, or splenic end, is the left extremity of the stomach. It lies beneath the ribs, in contact with the spleen, to which it is connected by the gastro-splenic omentum. The pylorus, or lesser end, of the stomach lies in

contact with the anterior wall of the abdomen, near the end of the cartilage of the right eighth rib. The lesser curvature is concave, extending from the esophageal to the pyloric orifice, along the upper border of the organ, is connected to the liver by the gastro-hepatic omentum, and to the diaphragm by the gastro-phrenic ligament. The greater curvature is convex, and extends between the same orifices, along the lower border, and gives attachment to the great omentum. The esophageal orifice is situated between the fundus and the lesser curvature. It is the highest part of the organ, and somewhat funnel-shaped. The pyloric orifice opens into the duodenum, the aperture being guarded by a kind of valve, the pylorus.

The arteries of the stomach are the gastric, arising from the cœliac axis, the pyloric and right gastro-epiploic branches of the hepatic, and the left gastro-epiploic and vasa branches of the splenic artery. Veins terminate in the splenic and portal veins.

The Small Intestine is a convoluted tube, about twenty feet in length, and is the organ in which chylification takes place. When the food enters the small intestine it is a grayish, semi-liquid mass called chyme. Here it is mixed with pancreatic juice, bile, and intestinal juice, all digestive fluids. The interior membrane is lined with hair-like projections called villi, which absorb the digested food into the circulatory system. The small intestine has three coats—a muscular, a cellular, or submucous, and a mucous. The mucous coat contains the crypts of Lieberkuhn, or simple follicles; the Brunner's, or duodenal, glands; and the solitary glands, situated throughout the intestine, though most numerous at the lower portion of the ileum. They are agminated into some twenty or thirty oval patches, named Peyer's patches, situated opposite the mesenteric attachments, some of which are as much as

four inches in length. They are most numerous and largest in the ileum. The small intestine is divided into three parts, duodenum, jejunum and ileum.

The Duodenum is so called from being equal in length to the breadth of twelve fingers (about ten inches). It is the shortest, the widest, and the most fixed part of the small intestine. It is only partially covered by the peritoneum, and has no mesentery. From the pylorus, it ascends obliquely upwards and backwards two and a half inches to the under surface of the liver, then decends three and a half inches in front of the kidney, and passes four inches transversly across the spine to the left side of the second lumbar vertebra, terminating in the jejunum, where the mesenteric artery crosses the intestine. The ductus communis choledochus and the pancreatic duct open into the descending portion.

The Jejunum (*jejunus*, empty) is so named from being usually found empty and includes about two-fifths of the rest of the intestine, its coils lying around the umbilical region.

The Ileum is so named from its twisted course, and comprises the remainder of the small intestine. It lies below the umbilicus, and terminates in the right iliac fossa, at the ileo-cæcal valve.

The Large Intestine extends from the termination of the ileum to the anus, and its chief office is the expulsion from the body of the undigested portions of food. It is about five feet in length, much larger than the small intestine, more fixed in position, and is sacculated. In its course it describes an arch, which surrounds the convolutions of the small intestine. It has the same coats as the small intestine, and is divided into the cæcum, colon, and rectum.

The Cæcum (*cæcus*, blind) is a blind pouch behind the entrance to the small intestine, lying in the right iliac

fossa. It is the beginning of the large intestine, of which it is the most dilated part, measuring two and one-half inches in diameter. It is two-thirds covered by peritoneum. The ileo-cæcal valve guards the entrance of the small intestine and when the cæcum is distended prevents any reflex into the ileum.

The Appendix Vermiformis is a narrow, worm-like tube, supposed to be the rudiment of the lengthened cæcum found in all mammalia, except the orang-outang and wombat. It is about the size of a goose quill and is three to six inches long. It is directed backwards and upwards from the lower part of the cæcum, being retained by a fold of the peritoneum.

The Colon extends from the ileum to the rectum and is divided into the ascending, transverse, and descending colons, and the sigmoid flexure. The ascending colon extends upwards to the under surface of the liver, where it forms the hepatic flexure of the colon. The transverse colon crosses the abdomen just below the liver, stomach, and spleen, to the left hypochondrium, where it terminates in the splenic flexure of the colon. The descending colon descends in front of the left kidney to the left iliac fossa. The sigmoid flexure of the colon is curved like an S, first upwards, then downwards, extending from the crest of the left ileum to the sacro-iliac synchondrosis.

The Rectum (*rectus*, straight) is the lower portion of the large intestine, extending from the sigmoid flexure to the anus. It is six or eight inches in length. The lower inch or inch and a half has no peritoneal investment. The sphincter ani closes the anus. The glands are the same as in the small intestine, except the absence of Brunner's glands.

The Liver is the largest glandular organ in the body, weighing from three to four pounds, and measuring trans-

versely about twelve inches, in its antero-posterior diameter about six or seven inches, and in its greatest thickness about three inches. It is intended mainly for the secretion of bile, but effects also important changes in certain constituents of the blood in their passage through the gland. It is situated in the right hypochondrium, and extends across the epigastrium into the left hypochondrium. Its upper surface is convex and its under surface concave. The right extremity of the liver is thick and rounded while the left side is thin and flattened. Five fissures on the under surface divide it into fives lobes—right lobe, left lobe, lobus quadratus, lobus Spigelii and lobus caudatus. The right and left lobes form the bulk of the liver; the others are merely lobules. The liver has five ligaments and five hepatic vessels.

The Hepatic Duct joins the cystic duct from the gall bladder to form the ductus communis choledochus, which carries the bile to the descending portion of the duodenum.

The Gall Bladder, the reservoir for the bile, is a conical, pear-shaped sac, three or four inches long, an inch in diameter, holding from an cunce to an ounce and a half, and lying on the under surface of the liver. Its secretion, called bile, is a viscid, golden-brown liquid, which is discharged from the gall bladder into the duodenum, and which aids in digestion, especially of the fats.

The Pancreas (the sweet bread) is a racemose gland, similar in structure to the salivary glands, is about seven inches in length, of grayish-white color, and situated behind the stomach. It secretes another digestive fluid, called the pancreatic juice. While the bile acts particularly on the fats, the pancreatic juice acts directly upon the sugars and starches, still undigested. The head extends to the right, and occupies a part of the epigastric region. The tail lies above the left kidney, and in contact with the lower

end of the spleen, and in the left hypochondriac region. The body lies behind the stomach and transverse colon and in front of the aorta, portal vein, inferior vena cava, splenic vein and the crura of the diaphragm. The arteries are the pancreatica magna and pancreaticæ parvæ, from the splenic; the pancreatico-duodenalis from the hepatic and from the superior mesenteric. The veins open into the splenic and mesenteric veins.

The Pancreatic Duct extends the whole length of the gland. It collects the pancreatic juice and carries it to the duodenum, which it enters about three inches below the pylorus, by an opening common to it and the ductus communis choledochus.

The Spleen, Thyroid, Thymus, and Supra-renal Capsules, constitute the ductless, or blood glands. The spleen possesses no excretory duct, and is of an oblong and flattened form, soft, of very brittle consistency, highly vascular, of a dark, bluish-red color, and situated in the left hypochondriac region, embracing the cardiac end of the stomach. It is about five inches long, three inches wide by two in thickness. The vessels are the splenic artery, which is large and tortuous, and the splenic vein, which empties into the portal vein.

The Supra-renal Capsules are two small, crecentric-shaped bodies, situated one on each kidney. The vessels are the supra-renal branches of the aorta, renal, and inferior phrenic arteries, and the supra-renal vein, which on the right side of the body empties into the inferior vena cava, and on the left side, into the left renal vein.

THE ABDOMINAL CAVITY.

The Abdomen is the largest cavity in the body and is situated between the thorax above and the pelvis below, and contains the :—

Stomach.	Pancreas.	Abdominal Aorta.
Intestines.	Kidneys and Ureters.	Inferior Vena Cava.
Liver.	Supra-renal Capsules.	Receptaculum Chyli.
Gall Bladder.	Bladder (when distended).	Thoracic Duct.
Spleen.	Uterus (during pregnancy).	Solar Plexus, etc.

It is bounded above by the diaphragm, below by the brim of the pelvis, at the back by the vertebral column and fasciæ covering the psoas and quadratus muscle, in front and at the sides by the transversalis fascia, the lower ribs, and the iliac venter. It contains the greater part of the alimentary canal, pancreas, spleen, kidneys and supra-renal capsules. The openings in the diaphragm are three in number, the aortic, the esophageal and the opening for the vena cava. The openings in the abdominal walls are five in number, the umbilical, two internal and two femoral or crural rings.

Regions of the Abdomen.—The abdomen, for convenience of description of its viscera, as well as of reference to the morbid condition of the contained parts, is artificially divided into nine regions, by two horizontal lines, one between the cartilages of the ninth ribs, another between the crests of the ilia, and two vertical lines from cartilages of the eighth rib on each side to the center of Poupart's ligament. The nine regions thus formed are named as follows:—

Right Hypochondriac.	Epigastric.	Left Hypochondriac.
Right Lumbar.	Umbilical.	Left Lumbar.
Right Inguinal.	Hypogastric.	Left Inguinal.

The Contents of these regions are respectively as follows:

Right Hypochondriac—right lobe of liver, gall bladder, duodenum, hepatic flexure of colon, upper part of right kidney, and right supra-renal capsule.

Epigastric—right two-thirds of stomach, left lobe and lobus Spigelii of liver, hepatic vessels, cœliac axis, solar

plexus, pancreas, and parts of aorta, inferior vena cava, vena azygos and thoracic duct.

Left Hypochondriac—splenic end of stomach, spleen, tail of pancreas, splenic flexure of colon, upper half of left kidney and its supra-renal capsule.

Right Lumbar—ascending colon, lower half of right kidney and part of small intestine.

Umbilical—transverse colon, transverse duodenum, part of the great omentum and mesentary, and part of small intestine.

Left Lumbar—descending colon, lower half of left kidney and part of small intestine.

Right Inguinal—right ureter, appendix vermiformis, and spermatic vessels of that side.

Hypogastric—part of small intestine, the bladder in children and when distended in adults and uterus during pregnancy.

Left Inguinal—left ureter and spermatic vessels, and sigmoid flexure of the colon.

The Peritoneum (to extend around) is a serous membrane, and, like all membranes of this class, is a shut sac. Its parietal layer is reflected more or less completely over all the abdominal and pelvic viscera. Its free surface is smooth, moist and shining. Its attached surface is connected to the viscera and the parietes of the abdomen by the subperitoneal, areolar tissue. In the female, it is not completely closed, the Fallopian tubes communicating with it by their free extremities and thus it is continuous with their mucous membranes.

Peritoneal Sacs.—The peritoneum is divided into two sacs, greater and lesser. The greater sac extends over the anterior two thirds of the liver, behind and above the stomach, below, behind, and in front of the great omentum, and below the mesocolon. The lesser sac, or cavity of

the great omentum, extends behind and below the liver and stomach, above the mesocolon, and within the great omentum.

The Omenta.—The great omentum consists of four layers of peritoneum, the most anterior and posterior of which belong to the greater sac and internal to the lesser sac. The two anterior layers descend from the stomach and the spleen, over the small intestines, and then ascend as the posterior layers, to enclose the transverse colon. The lesser omentum consists of two layers of peritoneum, the upper belonging to the greater sac, the lower to the lesser sac. It extends from the transverse fissure of the liver to the lesser curvature of the stomach, and contains in its right free margin the—

Hepatic Artery.	Ductus Communis Choledochus.
Portal Vein.	First Part of the Duodenum.
Lymphatics.	Hepatic Plexus of Nerves.

The gastrosplenic omentum connects the stomach with the spleen, and contains the splenic vessels and the vasa brevia.

The Mesos, or Mesenteries, are folds of peritoneum connecting the various parts of the intestinal canal (except the duodenum) to the abdominal walls. Each one contains the vessels of the mesentery proper, mesocæcum, mesocolon and mesorectum.

The Pelvic Cavity contains the bladder, male organs of generation, womb in female, and the rectum. The bladder lies behind the pubic arch. The womb lies behind the bladder in the female. During pregnancy it enlarges until at the latter end of the term, it nearly fills the abdominal cavity.

CHAPTER VI.

THE ORGANS OF RESPIRATION.

The Organs of Respiration consist of the respiratory tract, or air passages, the lungs and certain muscles which assist in the act of breathing. The respiratory tract consists of the passages of the nose and mouth, the pharynx, larynx, and the trachea, or windpipe.

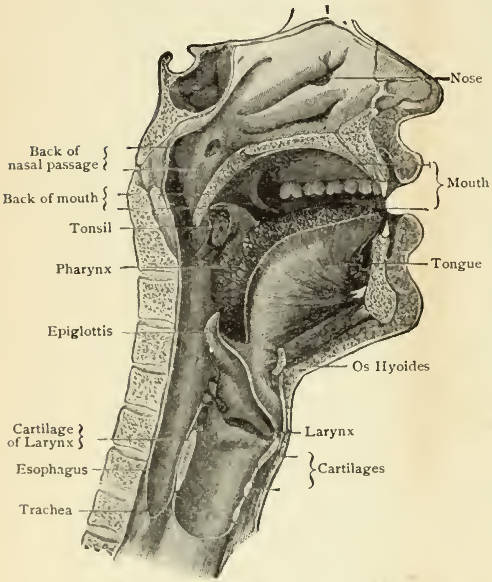


Fig. 8.
Sectional View of the Upper Air Passages.

Mouth and Nose.—The air passages begin with the mouth and nose. The proper passages for the air to enter in the act of breathing are those of the nose. These passages are lined with a smooth, soft membrane, called mucous membrane, the surface of which is increased by the projection into the nasal cavity of peculiarly shaped bones. This mucous membrane is constantly kept moist, thus catching particles of dust from the air as it passes through the nose and serving also to render the air moist to a certain extent. The air is also slightly warmed while passing through these passages. It is always better to

breathe through the nose than the mouth, as the latter cannot properly perform these offices.

The Pharynx, already described, has two openings in its lower part, one to the esophagus and the other to the larynx, through which the air passes on its way to the lungs.

The Larynx is a musculo-membranous, cartilaginous, triangular-shaped box, placed between the base of the tongue and the trachea. It is composed of nine cartilages: the thyroid, cricoid, epiglottis, two arytenoid and two cuneiform cartilages, and the two cornicula laryngis. Across its upper opening are stretched two fibrous bands, or cords, called the vocal cords, which are concerned in the production of the voice. Small muscles separate these cords as the air enters on its way towards the lungs, making a passage for the air between them. This opening is called the glottis. Just above is a leaf-like portion of cartilage, called the epiglottis, which, during the act of breathing, lies in such a position as to leave the larynx unobstructed. When food or drink is being swallowed, the epiglottis shuts down, closing the glottis and preventing the entrance of any foreign substances into the windpipe.

The Trachea, or Windpipe, is a membrano-cartilaginous, cylindrical tube, about four and a half inches in length, and one inch in diameter. It begins at the lower border of the larynx, opposite the fifth cervical vertebra, and ends opposite the third dorsal, by its bifurcation into the two bronchi. It is composed of a fibro-elastic membrane, containing from sixteen to twenty cartilaginous rings connected by muscular fibers, which keep the walls rigid and prevent their collapse during the act of breathing. The thyroid gland lies in front of the upper portion of the trachea.

The Bronchi are the right and left divisions of the trachea, which enter the lungs, dividing and subdividing into many bronchial tubes, ramifying all parts of the lungs. The last and most minute subdivisions are called bronchioles. A smooth, mucous membrane, which is constantly kept moist by a secretion of mucous, lines the trachea and bronchial tubes throughout, extending with the vessels into all parts of the lungs. The arteries are the tracheal branches of the inferior thyroid, and the bronchial branches of the thoracic aorta. The veins open into the thyroid plexus and the bronchial veins.

The Lungs, two in number, are the essential organs of respiration, contained in the thoracic cavity, one on each side. They weigh together about forty-two ounces, are conical in shape, and covered with a smooth membrane, called the pleura, which is deflected or turned back upon itself so as to line the chest walls. This membrane secretes a thin fluid which acts as a lubricator, preventing friction between the surface of the lungs and the chest walls during the act of breathing. The color of the lungs at birth is a pinkish white, which becomes mottled as age advances by slate colored patches, from the deposits of carbonaceous granules in the areolar tissue of the organ. The right lung is the larger and has three lobes, while the left lung is the smaller and has but two lobes. The apex of the lung projects into the neck about one inch above the first rib. The base is broad, concave, and rests on the upper surface of the diaphragm. The root of the lung is where the bronchial vessels and nerves enter the lung, bound together by areolar tissue.

Structure of the Lungs.—The lungs are invested with a serous coat (the pleuræ), a subserous, elastic areolar tissue, investing the entire organ and extending inwards between the lobules, and the parenchyma, or true lung

tissue, composed of lobules, each consisting of several air cells, arranged around the termination of a bronchiole, and surrounded by six plexuses of pulmonary and bronchial arteries and veins, lymphatics and nerves. The lungs are nourished by the bronchial arteries, and supplied with blood for oxygenation by the pulmonary arteries. The bronchial arteries are derived from the thoracic aorta and the pulmonary from the right ventricle of the heart. The bronchial veins open on the right side into the vena azygos and on the left side into the superior intercostal vein. The pulmonary veins open by four large orifices into the left auricle of the heart, carrying the oxygenated blood from the lungs to the heart.

The Pleuræ are two delicate serous sacs, one surrounding each lung and reflected over the pericardium, the diaphragm, and the inner surface of the thorax. The pleuræ meet for a short space behind the middle of the sternum, at the approximation of the anterior borders of the lungs. The visceral layer invests the lungs as far as the root, while the parietal layer lines the inner surface of the walls of the chest, the diaphragm and the pericardium. The cavity of the pleura is the space between the two layers. The mediastinum is the space between the two pleuræ in the medium line of the thorax, extending from the sternum to the vertebral column, and containing all the viscera of the chest except the lungs. This space contains the heart and pericardium, and the large vessels, esophagus, azygos veins, etc.

CHAPTER VII.

THE CIRCULATORY SYSTEM.

An Important System.—The constant wearing away of the organs and tissues of the body is as constantly being repaired by means of the nutriment furnished by the blood. This is carried and distributed by the circulatory system, which is necessarily one of importance.

In a work on embalming, a careful and thorough study of this wonderful system which permeates every portion, and almost every tissue of the body, is most necessary, and its treatment is therefore quite full.

Organs of Circulation.—The movement of the blood through and to every part of the body is called circulation, and the organs which produce and carry it on are called the organs of circulation. These are the heart and the blood vessels, and the latter are divided, according to the class of work done, into three classes, arteries, capillaries and veins.

THE HEART.

The Heart is a hollow, muscular organ, conical in shape, placed between the lungs, and inclosed in the cavity of the pericardium. The heart is placed obliquely in the chest, the base being directed upwards and backwards to the right, and the apex to the front and to the left, corresponding to the interspaces between the cartilages of the fifth and sixth ribs, one inch to the inner side and two inches below

the left nipple. It is placed behind the lower two-thirds of the sternum and projects farther into the left than into the right cavity of the chest, extending from the median line about three inches into the left, and only one and a half inches into the right cavity. Its anterior surface is round and convex and formed chiefly by the right ventricle and part of the left. Its posterior surface is flattened and rests upon the diaphragm, and is formed chiefly by the left ventricle.

The Pericardium (*peri,* around; *kardium,* heart) is a conical, membranous, closed sac, containing the heart and the roots of the great vessels. It lies behind the sternum and between the pleuræ, its apex upwards, its base below and attached to the tendon of the diaphragm. It is a sero-fibrous nembrane, the inner (serous) coat being reflected over the heart and vessels. Between the pericardium and the heart there is a small quantity of a clear fluid which acts as a lubricator, allowing the heart to move freely without producing any friction.

The Endocardium is a serous membrane which lines the auricles and ventricles of the heart.

Heart's Weight and Size.—In the adult the heart is about five inches in length, three and a half in breadth, and two and a half in thickness, being about the size of one's fist. It weighs from ten to twelve ounces in the male and from eight to ten ounces in the female. The heart increases in size and weight as age advances, but the increase is less marked in women than in men.

Its Cavities.—The interior of the heart is divided by a longitudinal, muscular septum into two lateral halves, which, from their position, are named the right and left. A transverse constriction divides each half into two cavities; the upper cavity on each side is called the auricle, and the lower cavity the ventricle. There are, therefore, a

right and left auricle and a right and left ventricle. The walls of the ventricles are thick and strong while those of the auricles are rather thin and less strong. The muscular septum of the heart is complete, no communication existing after fœtal life between the right and left sides. The right is the venous side of the heart and receives the venous blood from every portion of the body through the inferior and superior venæ cavæ and the coronary sinuses into the right auricle. The blood then passes from the right auricle into the right ventricle, and from the right ventricle through the pulmonary artery into the lungs for arterialization. It is returned as arterial blood, through the pulmonary veins to the left auricle; from the left auricle it passes into the left ventricle, and from the left ventricle it is carried through the aorta and its divisions to all parts of the body.

Its Capacity.—At each contraction of the heart each ventricle forces into the blood vessels about six ounces of blood. The average frequency of the pulse beat or heart contraction is seventy-two to seventy-six times per minute. It varies, however, in different persons, and in the same person under different conditions. Sudden emotions or sickness cause increase in frequency. It is also more frequent while a person is working than resting. The average amount of blood in the human body in normal condition is from sixteen to eighteen pounds; hence, it will be seen that all the blood in the body passes through the heart in about forty seconds. As the heart is unceasing in its work day and night, the aggregate force exerted by it in a day is something stupendous. It is estimated that over three hundred barrels of blood are pumped into, and forced out of, the heart every twenty-four hours.

The Right Auricle is larger than the left, and when full holds two fluid ounces Its walls are about a line

(one twelfth of an inch) in thickness. It consists of a principal cavity, or sinus, and an appendix auriculæ. Two large veins, the superior vena cava and the inferior vena cava, and the coronary sinus, open into the right auricle. The latter is guarded by a valve, while the former are not. The auriculo-ventricular opening communicating with the right ventricle is oval, about an inch broad, surrounded by a fibrous ring, and is guarded by the tricuspid valve. The latter allows the blood to flow only in one direction, from the auricle to the ventricle. The eustachian valve is a remnant of the fœtal circulation.

The Right Ventricle is conical in form and contains about two fluid ounces. The tricuspid valve consists of three triangular segments connected by their bases with the auriculo-ventricular orifice and by their sides with each other. The semilunar valves are three in number, and guard the orifice of the pulmonary artery. The opening of the pulmonary artery is at the superior and internal angle of the ventricle. It is circular in form, surrounded by a fibrous ring, and is guarded by the semilunar valves.

The Left Auricle is smaller than the right, its walls are a line and a half in thickness, and it receives the arterialized blood from the lungs. The openings of the pulmonary veins are generally four in number, sometimes only three, as the two left veins frequently end in a common opening. These openings are not guarded by valves. The left auriclo-ventricular opening is smaller than the right, and is guarded by the mitral valve.

The Left Ventricle is longer, thicker, and more conical than the right, projecting towards the posterior aspect. The walls are about twice as thick as those of the right ventricle. The aortic opening is small and circular, placed in front, and to the right, of the auriculo-ventricular opening, from which it is separated by one of the

segments of the mitral valve. It is surrounded by a fibrous ring and guarded by semilunar valves.

THE BLOOD.

The Blood is the liquid by means of which the circulation is effected. It permeates every part of the body except the cuticle, nails, hair, teeth, etc., its office being to carry nutrition to every tissue in the body. It is the most abundant fluid in the body, comprising about one eighth of its entire weight. The blood is composed of a thin, colorless liquid, the plasma, filled with red disks or cells. These cells are so minute that it takes thirty-two hundred laid side by side to measure an inch, and sixteen thousand if laid flatwise. A microscrope shows them to be rounded at the edges with concave sides. There is also a white globular cell to every three or four hundred red ones. The plasma also contains fibrin, albumen, and such mineral substances as iron, lime, magnesia, phosphorus, potash, etc. The blood contains the materials for building up every organ. The plasma is rich in mineral matter for the bones and albumen for the muscles. The red corpuscles contain oxygen, which is so essential to every operation of life. It stimulates to action and tears down all that is worn out. In the latter process it unites with, and burns out,

Fig. 9.—Blood Crystals.

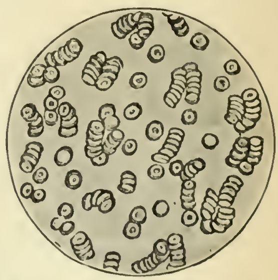


Fig. 10.—Blood Corpusles.

parts of muscles and other tissues, much as wood is burned. The unburned portion is caught up in the circulation, carried back to the lungs, where it undergoes purification, only to be again sent forth on its mission.

The Circulation of the Blood is an interesting study. The blood goes from the heart and then returns again to the heart. Starting with the left ventricle the blood is forced through the aorta and its branches to all parts of the body. From the arteries it passes through the capillaries. The second set of capillaries then take it up, pass it into the veins and then in turn into the venæ cavæ, whence it is emptied into the right auricle of the heart. It then passes into the right ventricle from whence it is sent through the pulmonary artery to the lungs, to be returned through the pulmonary vein to the left auricle and then into the left ventricle, from which place it started. Blood, when it leaves the left ventricle, and while it is in the arteries, is red in color; when returning through the veins it is bluish. Arterial blood is pure and contains much oxygen; venous blood is impure, containing much carbonic acid and other waste matter. The blue, impure blood passing through the lungs loses its carbonic acid and takes up oxygen, becoming again bright red in color.

THE ARTERIES.

The Arteries are the vessels or canals which convey the blood from the heart to different parts of the body. They are dense, very elastic, and cylindrical in form. They are composed of three coats: an internal or serous; a middle, of muscular and elastic tissue; and an external, of connective tissue. They are accompanied by veins with which the arteries are generally enclosed in a fibro-areolar investment, the sheath. The external and middle coats of the large arteries are nourished by the vasa vasorum. The arteries anastomose or communicate freely with each other

everywhere throughout the body, permitting the establishment of collateral circulations. They are generally located as far as possible out of harm's way and are commonly found close to the bones or running through safe passages provided for them. They are usually very straight and take the shortest route to the part of the body to be supplied by them with blood. The arteries that convey the blood to the lungs, with the veins that return the blood to the heart, form the lesser or pulmonic circulation. The aorta with its branches and returning veins, form the greater or systemic circulation.

THE SYSTEMIC CIRCULATION.

The Aorta, or great artery, is the main trunk of the systemic circulation. It commences at the aortic opening of the left ventricle of the heart, arching backwards over the root of the left lung into the posterior part of the thorax, where it descends on the left side of the spinal column, through the aortic opening of the diaphragm, to the fourth lumbar vertebra, where it divides into the right and left common iliac arteries. The aorta is divided into the arch, the thoracic aorta, and the abdominal aorta. The arch is subdivided into an ascending, transverse and descending portion. The upper border of the arch is located about an inch below the upper margin of the sternum and ends at the lower border of the third dorsal vertebra. The branches of the aorta are:

From the Arch.	Two Coronary. Innominate.	Left Common Carotid. Left Subclavian.
From the Thoracic.	Pericardiac. Bronchial.	Esophageal. Twenty Intercostals. Posterior Mediastinal.
From the Abdominal — Two Phrenic.		
Coeliac Axis.	Gastric. Hepatic. Splenic.	Two Spermatic. Inferior Mesenteric. Eight Lumbar.
Superior Mesenteric.	Sacra Media.	
Two Supra-renal.	Two Common Iliac.	
Two Renal.		

The Coronary Arteries arise from the aorta behind the semilunar valves, and run in the vertical grooves of the heart, to supply the tissues of the heart.

The Innominate Artery arises from the summit of the arch of the aorta, is one and a half inches in length, and divides at the right sterno-clavicular articulation into the right common carotid and right subclavian arteries. On the left side these arise directly from the arch of the aorta.

The Common Carotid Artery on the left side arises from the aorta, and the right from the innominate, the left being longer and deeper than the right. Their course is indicated by a line drawn from a point midway between the angle of the lower jaw and the mastoid process to the sterno-clavicular articulations. At the lower part of the neck they are separated only by the width of the trachea, and they are each contained in a sheath of the deep cervical fascia with the internal jugular vein externally and the pneumogastric nerve between the artery and vein. It divides at the left level of the upper border of the thyroid cartilage into the external and internal carotids.

The External Carotid Artery ascends from its origin to the space between the neck of the ramus of the lower jaw and the external auditory canal, where it divides into the temporal and internal maxillary arteries. The branches of the external carotid are:—

The Superior Thyroid.	The Occipital.
The Lingual.	The Posterior Auricular.
The Facial.	The Temporal.
The Ascending Pharyngeal.	The Internal Maxillary.

These branches and their subdivisions supply the tissues of the neck, face, mouth, and head, and the branches of one side anastomose freely with those on the other side.

The Internal Carotid Artery ascends in front of the transverse processes of the upper cervical vertebra, and close to the tonsil, traverses the carotid canal in the temporal bone, and, after piercing the dura mater by the anterior cleinoid process, divides into its terminal branches. These branches of the internal carotid are:

(1) **The Tympanic,** supplying the tympanum.

(2) **The Arteriæ Receptaculi,** supplying the walls of the sinuses, the Casserian ganglion and the pituitary body.

(3) **The Anterior Meningeal,** distributing to the dura mater.

(4) **The Ophthalmic,** supplying the eye and its appendages.

(5) **The Anterior Cerebral** is joined to its fellow by the anterior communicating branch, which is about two inches long.

(6) **The Middle Cerebral** divides into the anterior, median, and posterior cerebral arteries.

(7) **The Anterior Choroid** supplies the choroid plexus, corpus fimbriatum, etc.

(8) **The Posterior Communicating** anastomoses with the posterior cerebral, a branch of the basilar.

The Circle of Willis is an anastomosis at the base of the brain, between the branches of the internal carotid and vertebral arteries, to equalize the cerebral circulation. The two vertebral arteries join to form the basilar, which ends in the two posterior cerebral. These are connected with the internal carotid by the two posterior communicating. The circle is completed by the connection of the two anterior cerebral branches of the internal carotid through the short anterior communicating artery.

The Subclavian Artery arises on the right side from the innominate, and on the left from the arch of the aorta, and is divided into three portions by the scalenus anticus,

the parts being internal, posterior, and external, to that muscle. At the outer border of the first rib, the subclavian becomes the axillary artery. Its branches are about all given off from its first portion.

The Vertebral Artery passes up the neck, through the foramen in the transverse processes of six cervical vertebræ, and enters the skull by the foramen magnum, where it joins its fellow to form the basilar artery. The branches of the vertebral artery supply the tissues of the back part of the neck and spine.

The Thyroid Axis divides into three branches :

(1) **The Inferior Thyroid,** supplying the thyroid gland, the larynx, the trachea, the esophageal, and the ascending cervical branch.

(2) **The Transversalis Colli** and

(3) **Suprascapular,** supplying the superficial tissue of the neck, the back of the scapula, and the shoulder joint.

The Internal Mammary Artery descends along the costal cartilages to the sixth interspace, where it divides into the musculo-phrenic and superior epigastric, the latter anastomosing with the deep epigastric branch of the external iliac. It gives off branches to the diaphragm, mediastinum, pericardium, sternum, intercostal spaces, etc.

The Superior Intercostal Artery gives off branches to the intercostal spaces, to the posterior spinal muscles, and to the spinal cord.

The Axillary Artery is the continuation of the subclavian, extending from the outer border of the first rib to the lower margin of the axillary space (armpit), where it becomes the brachial. Its seven branches supply all the tissues of the thorax, shoulder, and mammary gland.

The Brachial Artery is the continuation of the axillary from the lower border of the armpit to where it

divides into the radial and ulnar, which is usually about one half inch below the bend of the elbow. Its branches are the:

Superior profunda, nutrient, inferior profunda, anastomatica magna, and muscular branches, supplying the tissues of the arm, and forming important anastomoses with branches above and below the arm.

The Radial Artery is one of the divisions of the brachial, extending from the bifurcation to the deep palmar arch, on the radial side of the forearm, and terminates by anastomosing with the superficial palmar arch. Its branches supply the tissues of the radial side of the forearm, wrist and hand, and inosculate with the branches from the brachial artery.

The Ulnar Artery is the other division of the brachial, along the ulnar side of the forearm. Its branches supply the tissues on the ulnar side of the forearm, wrist, and hand, and anastomose freely with branches of the ulnar and brachial arteries.

The Superficial Arch is that part of the ulnar artery lying in the palm of the hand, and anastomosing with the superficialis volæ from the radial, and a branch from the radialis indicis, at the root of the thumb. It gives off the digital branches, four in number, to the sides of the fingers, except the inside of the index finger, which is supplied by the radialis indicis.

The Deep Palmar Arch is formed by the palmar portion of the radial artery anastomosing with the deep or communicating branch of the ulna. It gives off the radialis indicis, palmar interosseous, perforating and recurrent branches.

The Thoracic Aorta begins at the lower border of the third dorsal vertebra, and descends along the left side of the spine to the aortic opening in the diaphragm, where it

ends directly in front of the last dorsal vertebra. Its branches are:

(1) **The Pericardiac Branches** vary in number and origin.

(2) **The Bronchial Arteries** supply all the tissues of the lungs. They vary in number and origin, being usually one on the right side and two on the left side.

(3) **The Esophageal Branches** supply the esophagus.

(4) **The Posterior Mediastinals** supply the mediastinum.

(5) **The Intercostals,** usually ten in number on each side, divide into anterior and posterior branches, supplying the upper spaces and the spinal cord and tissues of the back.

The Abdominal Aorta descends along the spinal column from the diaphragm to the fourth dorsal vertebra, where it divides into the right and left common iliac arteries. It diminishes in size rapidly on account of the many large branches given off in its course. Its branches are:

(1) **The Phrenic,** supplying the under surface of the diaphragm.

(2) **The Cœliac Axis**, arising near the diaphragm, running forwards for half an inch and dividing into the gastric, hepatic and splenic arteries.

(a) **The Gastric,** supplying the liver and gall bladder, the pyloric end of the stomach, duodenum and pancreas.

(b) **The Hepatic,** supplying the liver.

(c) **The Splenic,** supplying the spleen and giving off branches to the pancreas and to the left or cardiac end of the stomach.

(3) **The Superior Mesenteric,** supplying the small intestine, cæcum, ascending and transverse colon. It arises about one fourth of an inch below the cœliac axis,

arching forwards and downwards, to the left, and gives off branches: inferior pancreatico-duodenal, vasa intestini tenuis, ileo-colic, and right and middle colic.

(4) **The Inferior Mesenteric,** supplying the descending colon, sigmoid flexure, and most of the rectum, giving off the following branches: the left colic, sigmoid, and superior hemorrhoidal.

(5) **The Suprarenal,** supplying the suprarenal capsules.

(6) **The Spermatics,** supplying the testes in the male, and the ovaries, uterus, and the skin of the labia and groins in the female.

(7) **The Renal,** one on each side, supplying the kidneys.

(8) **The Lumbar,** usually four on each side, supplying the lumbar vertebræ.

(9) **The Sacra Media,** arising at the division of the aorta and supplying the sacrum and coccyx.

The Common Iliac Arteries extend from the division of the aorta at the fourth lumbar vertebra, to the margin of the pelvis, where they each divide into the external and internal iliac arteries. The common iliacs are about two inches long, the right being somewhat larger than the left.

The Internal Iliac is about one and a half inches long. It divides into an anterior and a posterior trunk, which give off many branches to supply the walls and viscera of the pelvis, and the inner side of the thigh.

The External Iliac Artery extends to and beneath the centre of Poupart's ligament, where it enters the thigh and becomes the femoral artery. Its branches are:

(1) **The Epigastric,** usually arising a few lines above Poupart's ligament, passes between the peritoneum and the transversalis fascia, to the sheath of the rectus which it perforates, and ascends behind that muscle, to anastomose by numerous branches with the terminal branches of the internal mammary and inferior intercostal.

(2) **The Circumflex Iliac** passes along the crest of the ilium to anastomose with the ilio-lumbar, gluteal, lumbar and epigastric arteries.

The Femoral Artery extends from Poupart's ligament to the opening in the adductor magnus muscle, where it becomes the popliteal artery. Its course corresponds to a line drawn from the center of Poupart's ligament to the inner side of the inner condyle of the femur. It lies in a strong fibrous sheath with the femoral vein on the inside and the anterior crural nerve on the outside. In Scarpa's triangle it lies superficial, in the upper third of its course. Its branches are:

(1) **The Superficial Epigastric,** supplying the superficial fascia of the abdomen.

(2) **The Superficial Circumflex Iliac,** to the skin over the iliac crest.

(3) **The Superficial External Pudic,** to the skin of the lower abdomen, penis, and scrotum.

(4) **The Deep External Pudic,** to the skin of the scrotum and perinæum.

(5) **The Profunda Femoris** arises posteriorly about one or two inches below Poupart's ligament, and descends to the lower third of the back of the thigh, giving off the following branches: external circumflex. internal circumflex, and three perforating.

(6) **The Muscular Branches,** to the sartorius and vastus internus muscles.

(7) **The Anastomotica Magna,** arising in Hunter's canal, divides into a superficial and a deep branch, the latter anastomosing around the knee joint with the articular arteries and the recurrent tibial.

The Popliteal Artery extends downwards through the popliteal space behind the knee, dividing into the anterior and posterior tibial artery, which supply the knee joint and tissues around the knee.

The Anterior Tibial Artery extends from the division of the popliteal to the front of the ankle-joint, where it becomes the dorsalis pedis. It is superficial in its lower third, lying on the anterior surface of the tibia. Its branches supply the tissues in its course and it gives off the internal and external malleolar at its lower part.

The Dorsalis Pedis Artery extends from the front of the ankle to the first interosseous space, where it terminates in the dorsalis hallucis and the communicating. It gives off branches to the outer and front part of the foot and the toes.

The Posterior Tibial Artery extends from the division of the popliteal along the back of the tibia to the fossa below the internal malleolus, where it divides into the internal and external plantar. Its branches supply the tissues of the leg, heel and sole of the foot.

The Internal Plantar passes along the inner side of the foot and great toe.

The External Plantar passes along outwards and forwards, and at the base of the metatarsal bones it inosculates with the communicating branches from the dorsalis pedis, forming the plantar arch. Its branches supply the muscles on the outer part of the foot, interosseous tissues, the three outer toes and the outer side of the second toe.

THE LESSER OR PULMONARY CIRCULATION.

The Pulmonary Artery is the only artery that carries venous blood, which it conveys from the right ventricle of the heart to the lungs. It is about two inches long, passes upward and backward to the under surface of the aorta, where it divides and is connected to the aorta by a fibrous cord, the remains of the ductus arteriosus of the fœtus. Its terminal branches are:

The Right and Left Pulmonary Arteries which, passing outward to the roots of their respective lungs, divide and subdivide to ramify throughout the lung tissue and end in the capillaries of those organs.

THE VEINS.

The Veins are the vessels that carry the blood towards the heart. They have three coats: an internal, serous; a middle, muscular; and an external, fibrous. They all carry carbonized or venous blood to the right side of the heart, except the pulmonary veins, which convey oxygenated blood to the left side of the heart. The deep veins accompany the arteries, usually in the same sheath, and are given the same names. The secondary arteries, as the radial, ulna, brachial, etc., have each two veins, called venæ comites. The superficial veins are usually unaccompanied by arteries, and lie, as a rule, between the layers of the superficial fascia, terminating in the deep veins. The veins all anastomose with each other much more freely than do the arteries.


Fig. 11. Venous Valves.

Venous Valves.—In the veins are numerous valves arranged to allow the blood to flow through them only in the direction of the heart.

The Sinuses are venous channels, differing from veins in structure, but serving the same purpose. The sinuses of the cranium are formed by the separation of the layers of the dura mater.

The Veins are Divided into the pulmonary, systemic, and portal systems. The veins which have no valves are the venæ cavæ, hepatic, portal, renal, uterine, ovarian, cerebral, spinal, pulmonary, umbilical, and the very small veins.

Veins of the Head.—The principal veins of the head and neck, are:

(1) **The External Veins:**

1. Facial.
2. Temporal.
3. Internal Maxillary.
4. Temporo-Maxillary.
5. Posterior Auricular.
6. Occipital.

(2) **Veins of the Diploe and Cranium:**

1. Veins of the Diploe.
2. Cerebral and Cerebellar.
3. Superior Longitudinal Sinus.
4. Inferior Longitudinal Sinus.
5. Straight Sinus.
6. Circular Sinus.
7. Transverse Sinus.
8. Cavernous Sinus.
9. Occipital Sinus.
10. Superior Petrosal Sinus.
11. Inferior Petrosal Sinus.
12. Lateral Sinus.

Veins of the Neck, draining the above named, are the:

(1) **External Jugular,** terminating in the subclavian vein.

(2) **Posterior External Jugular** runs down the back part of the neck, opening into the external jugular, just below the middle of its course.

(3) **Anterior Jugular** enters the subclavian vein near the external jugular.

(4) **Internal Jugular** collects the blood from the interior of the cranium, from the superficial parts of the face, and from the neck. It is formed by the junction of the lateral and the inferior petrosal sinuses, descending and uniting with the subclavian vein at the root of the neck to form the innominate. It receives in its course the facial, lingual, pharyngeal, superior and middle thyroid, and the occipital veins.

(5) **The Vertebral** empties into the innominate vein.

The Veins of the Upper Extremity are superficial and deep. The deep veins accompany the arteries, usually as venæ comites. Beginning in the hand as digital, interosseous, and palmar veins, they unite in the deep radial and ulnar, which unite to form the venæ comites of the brachial artery at the elbow. The superficial veins lie in the superficial fascia. Those of the forearm are the radial,

cephalic, median, anterior and posterior ulna. The two latter form the basilic at the inner side of the elbow, and, receiving the median basilic, passes upwards on the inner side of the arm, pierces the deep fascia and ascends in the course of the brachial artery, terminating either in one of the venæ comites of that vessel or in the axillary vein.

The Radial Vein terminates at the outer side of the elbow.

The Cephalic Vein ascends on the outer border of the biceps muscle, receives the median cephalic, and terminates in the axillary vein just below the clavicle.

The Median Vein forms the median basilic and the median cephalic just below the elbow.

The Principal Veins of the Thorax are:

INTERNAL MAMMARY	BRONCHIAL.	RIGHT AZYGOS (MAJOR).
INFERIOR THYROID.	MEDIASTINAL.	LEFT LOWER AZYGOS (MINOR).
INTERCOSTAL.	PERICARDIAC.	LEFT UPPER AZYGOS (MINIMUS).

The Azygos Veins supply the place of the venæ cavæ in the region where these trunks are deficient, being connected with the heart.

The Right Azygos begins by a branch from the right lumbar veins, passes through the aorta opening in the diaphragm, and ends in the superior vena cava, having drained nine or ten of the right lower intercostals, the vena azygos minor, the right bronchial esophageal, mediastinal, and vertebral veins.

The Left Lower Azygos begins by a branch from the left lumbar or renal, passes the left crus of the diaphragm, crosses the vertebral column and ends in the right azygos, having drained four or five lower intercostals.

The Left Upper Azygos is often wanting.

The Spinal Veins empty into the vertebral, intercostal, and others.

The Subclavian Vein is the continuation of the axillary, extending from the outer margin of the first rib

to the sterno-clavicular articulation, where it unites with the internal jugular to form the innominate vein. At the angle of this junction the thoracic duct enters on the left side, and the right lymphatic duct enters on the right side. It receives the external and anterior jugular, and a branch from the cephalic, in its course.

The Innominate Veins are each formed by the subclavian and internal jugular, and unite below the first costal cartilage to form the superior vena cava. The right is one and a half inches long and the left is about three inches long.

The Superior Vena Cava is about three inches long, receives all the blood from the upper half of the body, and terminates in the right auricle of the heart. It is partly covered by the pericardium, and receives the vena azygos major and small pericardiac and mediastinal veins.

The Veins of the Lower Extremity are superficial and deep. The deep veins are the venæ comites of the anterior and posterior tibial and peroneal arteries, which collect the blood from the deep parts of the foot and leg, and unite in the popliteal, which becomes the femoral and the external iliac in the same manner as the respectively named arteries.

The Superficial Veins of the lower extremities are :

The Internal or Long Saphenous, on the inside of the leg and thigh, enters the femoral at the saphenous opening, one and a half inches below Poupart's ligament. In its course it receives the blood from the superficial branches of the leg.

The External or Short Saphenous is formed by the branches from the dorsum and outer side of the foot, and ascends behind the outer malleolus up the middle of the back of the leg, and empties into the popliteal vein.

The Internal Iliac Vein is formed by the venæ comites of the branches of the internal iliac artery, except the um-

bilical. It terminates with the external iliac to form the common iliac vein. It receives the gluteal, sciatic, internal pudic, obturator, hemorrhoidal, and vesico-prostatic, in the male, and uterine and vaginal plexuses, in the female.

The Common Iliac Veins are each formed by the junction of two iliac veins, and unite between the fourth and fifth lumbar vertebræ to form the inferior vena cava, the right common iliac being the shorter of the two.

The Inferior Vena Cava extends from the junction of the two common iliac arteries and passes along the front of the spine, through the tendinous center of the diaphragm, to its termination in the right auricle of the heart. It receives in its course the lumbar, right spermatic, renal, suprarenal, phrenic and hepatic veins.

THE PORTAL SYSTEM.

The Portal System is an appendage of the systemic. It is formed by the superior and inferior mesenteric, splenic, and gastric veins, which collect the blood from the digestive viscera, and, by their junction behind the head of the pancreas, form the portal vein, which enters the liver, where it divides into two branches, and these again subdivide, ramifying throughout that organ, therein receiving blood from the branches of the hepatic artery.

The Hepatic Vein collects the blood from the liver and carries it to the inferior vena cava.

The Portal Vein is about four inches in length.

The Cardiac Veins return the blood from the tissues of the heart into the right auricle. They are the posterior and anterior and great cardiac veins, venæ Thebesii and the coronary sinus.

THE PULMONARY SYSTEM.

The Pulmonary Veins are the only veins that carry arterial blood. They originate in the capillaries of the

lungs, forming a single trunk for each lobe, which unite to form two main trunks from each lung that open separately into the left auricle of the heart. The three lobe trunks of the right lung sometimes remain separate to their termination in the left auricle. Occasionally the two left pulmonary veins enter the auricle by a common opening.

THE CAPILLARIES.

The Capillaries are a minute network of vessels formed throughout the tissues of the body between the terminating arteries and the commencing veins. They so blend, however, with the extremities of these two systems, that it is not easy to tell just where any artery ends and a vein begins. Their diameter is from one three-thousandths to one six-thousandths of an inch. They exist in every part of the tissues of the body and are so closely packed together that it is impossible to prick the skin with the point of a needle without injuring many of them. In many instances they are smaller than the blood corpuscles. These bodies must move in a single line and must be changed in form to pass through the smallest vessels. By union with each other the capillaries form a true plexus of vessels of nearly uniform diameter, branching and inosculating in every direction, distributing blood to all parts as their necessities demand. They receive the blood from the smallest subdivisions of the arteries and carry on the work of nourishing and rebuilding the body. They also begin the process by removing the waste matter from the worn-out portions of the tissues, turning it over to the veins. Their walls consist of a transparent, homogeneous membrane, continuous with the innermost layer of the arterial and venous walls.

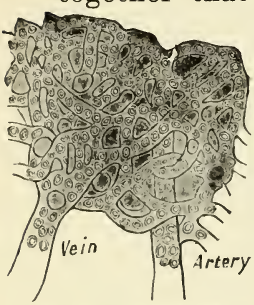


Fig. 12.—Capillaries.

THE FŒTAL CIRCULATION.

The fœtal circulation is the circulation of the unborn child. It is carried on somewhat different from that of the adult circulation. In the adult the right and left sides of the heart are divided by a solid partition, a muscular septum. In the fœtal circulation there is a communication, the foramen ovale, between the right and left auricle. By this arrangement the blood passes directly from the right auricle, guided by the eustachian valve, through the foramen ovale, to the left auricle, thence to the left ventricle. From the left ventricle the blood is sent through the circulation into the tissues, the principal part going to the upper extremities and the head; very little going to the lower extremities. From the head and upper extremities the blood is returned through the superior vena cava to the right auricle, passing over the eustachian valve into the right ventricle, from which it passes into the pulmonary artery. The lungs being solid, only a small quantity of the blood is distributed to them, which is returned by the pulmonary veins to the left auricle, the greater part passing through the ductus arteriosus into the commencement of the descending aorta. Along this vessel the blood descends to supply the lower extremities, the viscera of the abdomen, and the pelvis. The principal portion, however, is conveyed by the umbilical arteries to the placenta, where it is purified and returned again through the umbilical veins to the lower portion of the liver, where the vessel divides into two branches, the larger entering, and passing through, the liver, becoming the hepatic veins. The blood is not purified in the lungs during fœtal life, because respiration is not established and no air comes into the lungs, it being wholly dependent upon the mother; hence purification takes place in the placenta.

CHAPTER VIII.

THE ORGANS OF SPECIAL SENSES.

THE EYE.

The eye is the organ of sight, and is situated in a bony cavity of the skull. protected by the overhanging brow. The eyeball is spherical in shape and about one inch in diameter. It is covered with three membranes ; the sclerotic, the choroid, and the retina.

The Membranes. — (1) The sclerotic, the outer membrane. is tough and hard, giving form and shape to the eye. This comprises what is known as the white of the eye, and completely surrounds the eyeball, the small, transparent portion in front being called the cornea. (2) The choroid. the middle membrane, lies immediately within the sclerotic, contains numerous blood vessels, and is of a dark color — its purpose being to absorb the superfluous light. (3) The retina, the inner and last membrane, is of a delicate structure, and contains a complicated arrangement of nervous tissue. given off from the optic nerve. It is the retina which gives rise to the sensation of sight.

Chambers of the Eye. — The interior of the eyeball is filled with a translucent. glutinous substance, called the vitreous humor. Between this and the cornea in front is situated a small, transparent body, the crystalline lens. which brings the rays of light to a focus in the retina. The lens is kept in place by the ciliary processes, which

are arranged like the rays in the disk of a passion flower. In front of the crystalline lens is a muscular, curtain-like arrangement called the iris (rainbow). In this curtain is a circular opening, which forms the pupil of the eye. A clear, limpid fluid, called aqueous humor, fills the space between the crystalline lens and the cornea.

The Retina never exceeds one eightieth of an inch in thickness. A lining membrance covers the inner surface. About one fourth of the outer thickness of the retina is composed of a multitude of colorless, transparent rods, packed side by side, like the seeds in the disk of a sunflower. These rods are interspersed with cones. From the ends of the rods and cones delicate nerve fibers emanate, expanding into glandular bodies. A layer of fine nerve fibers and gray ganglions, much like the gray matter of the brain, constitutes the interior portion of the retina. From these ganglions emanate filaments which unite with the fibers of the optic nerve. The rods and cones are to the eye what the bristles, otoliths and Cortian fibers are to the ear.

The Iris is, as has been said, a curtain with a round opening in the middle, provided with circular and radiating, unstriped, muscular fibers, by the action of which the central aperture may be enlarged or diminished. This is an important use of the iris, for by its contractions and expansions the amount of light admitted into the eye is regulated, as all the light entering the eye enters through the pupil. Too much light irritates the retina. To prevent this the iris contracts and the pupil becomes smaller. If too little light is received, more light is allowed to enter by the iris relaxing and thus allowing the pupil to become larger. The contraction of these fibers, unlike the action of unstriped, muscular fibers generally, on account of their peculiar arrangement, is very rapid. The admission of the rays of light through the pupil, which is immediately

in front of the crystalline lens, prevents the image, which falls upon the retina, from being blurred, as would otherwise be the case. The color of the eye is also determined by the iris, being different in different persons.

The Eyelids are folds of skin which may be drawn over the eyeball, serving as a screen to protect it. It is lined on its inner surface with an exceedingly sensitive, mucous membrane, which aids in preventing injury to the eye from any irritating substances. The eyelashes, which fringe the eyelids on their free edges, serve as a kind of sieve to exclude dust and other foreign bodies, and also shield the eye from too strong light. An oily substance is secreted by a series of small glands, called the Meibomian, located on the inner surface of the eyelids, which acts as a lubricator. This substance, covering the edge of the lids, prevents the lids from adhering to each other, and also intercepts the overflow of tears upon the cheek.

The Lachrymal Gland is situated in a depression of the bony wall of the orbit, at its outer angle. It is of an oval form, of about the size of an almond, and its office is to secrete the tears, which flow through small ducts and are spread out upon the eyeball. This secretion is constantly being formed, keeping the eyeball moist, and further assisting in preventing friction between the ball and lids, and also in washing out dust, or other foreign matter, which find their way into the eye. At the inner angle of the eye is a small basin, called the lachrymal reservoir, which receives the overflow. At either side of this basin are two small canals through which the overplus passes into the nasal duct, which empties into the nose.

THE EAR.

The ear, the organ of hearing, is a very complicated and important portion of the human anatomy. It consists

of three parts: (1) The external ear; (2) the middle ear; and (3) the internal ear.

The External Ear is too conspicuous and well known to need much description. It is composed of a curiously folded sheet of cartilage, covered with skin, arranged to catch sound. Attached to it are three small muscles, scarcely more than rudimentary in man, but fully developed in many animals, so that the ear can be freely moved. From the outer ear a tube, or canal, called the auditory canal, or external auditory meatus, extends inward about an inch or an inch and a quarter. A thin membrane, called the drum, or membrane of the tympanum, is stretched across the inner end. This membrane is kept soft and elastic by the secretion of a waxy substance, called the ear wax, or cerumen. Short, stiff hairs spring from the walls of the canal, preventing the entrance of insects and foreign bodies.

The Middle Ear is located just within the drum of the ear, and is a small, irregularly-shaped chamber, or cavity, called the tympanum. Across this chamber hangs a chain of three tiny bones, the auditory ossicles, named respectively; (1) stapes (stirrup); (2) malleus (hammer); and (3) incus (anvil). These bones are so very small that they weigh together but a few grains, yet they are covered by periosteum, are supplied with blood vessels, and articulate with each other with perfect joints, and the joints in turn have synovial membranes, cartilages, ligaments and muscles. The malleus is attached to the drum of the ear and the stapes to a membrane of the internal ear, while the incus lies between the other two. A thin, delicate membrane separates the middle from the internal ear. Opening into the middle ear is a small canal, called the eustachian tube, which leads to the upper part of the throat.

The Internal Ear is a cavity, very irregular in shape and complicated in structure, hollowed out of the solid bone. From its complex character it is sometimes called the labyrinth. It is made up, in large part, of spiral tubes, which open in front into a sort of court, or ante chamber, about the size of a grain of wheat, called the vestibule. These spiral tubes consist of three semicircular canals and the winding stair of the cochlea, or snail shell, which coils around two and one half times. In the walls of the internal ear are expanded the delicate fibrils of the auditory nerve. The labyrinth is filled with watery fluid, in which floats a little bag containing hair-like bristles, fine sand, and two earstones, called otoliths. Within the cochlea are minute tendrils, termed the fibers of Corti, which are regularly arranged, the longest at the bottom and the shortest at the top.

OTHER SPECIAL ORGANS.

The Nose, the organ of smell, is the most conspicuous feature of the face. The nasal passages, or chambers, are lined with mucous membrane, in which are distributed the fine branches, or filaments, of the olfactory nerve. These enter through a sieve-like, bony plate at the roof of the nose. The nostrils open at the back into the pharynx.

The Tongue, the organ of taste, has already been fully described under " The Digestive Organs " (Chapter V).

Touch, the remaining "special sense." has no special organ, its nerves being spread over the entire body.

CHAPTER IX.

THE BODY: ITS WEIGHT AND CONSTITUENTS.

WEIGHT OF THE DIFFERENT PARTS OF THE BODY.

THE weight of the different parts of the human body of average size is about as follows:

	LBS.	OZ.
THE SKELETON,	21	8
MUSCLES AND TENDONS,	77	8
SKIN AND SUBCUTANEOUS FAT,	16	5
BRAIN,	3	2½
EYES,		½
SPINAL CORD,		1¼
TONGUE AND HYOID BONE,		3
ESOPHAGUS,		1¼
STOMACH,		7
SMALL INTESTINE,	1	11½
LARGE INTESTINE,	1	1½
SALIVARY GLANDS,		2½
LIVER,	4	1½
PANCREAS,		3
SPLEEN,		8½
THYROID GLAND AND REMAINS OF THYMUS,		¾
BLOOD (⅛ WEIGHT OF BODY), ABOUT	17	
HEART,		10¼
KIDNEYS,		10¼
LARYNX, TRACHEA AND LARGE BRONCHI,		2¾
LUNGS,	2	10¼
UNWEIGHED PARTS,	1	12¾
TOTAL,	150	00

THE CHEMICAL CONSTITUENTS OF THE BODY.

The chief, inorganic, proximate constituent of the body is water, which amounts to about sixty-one per cent. Next in quantity are calcium phosphate, calcium carbonate, sodium chlorid, potassium chlorid, phosphates, sulphates and carbonates of soda and potash, phosphates and carbonates of magnesium, fluoride of calcium, and certain compounds containing iron, silica and manganese, besides traces of probably accidental substances—such as copper, lead and aluminum. To these we must add ammonium, which exists in combination with the urine, and likewise carbonic acid, oxygen and hydrogen gases.

The percentage of proportions of the ultimate elements are as follows:

Oxygen,	72.
Hydrogen,	9.1
Nitrogen,	2.5
Chlorin,	.085
Fluorine,	.08
Carbon,	13.5
Phosphorus,	1.15
Calcium,	1.3
Sulphur,	.1476
Sodium,	.1
Potassium,	.026
Iron,	.01
Magnesium,	.0012
Silica,	.0002
Total,	100.0000

The entire body, with its natural moisture, is therefore composed of about eighty-four parts of gaseous elements, to sixteen parts of solid elements. The greater part of the oxygen and hydrogen exists in the state of water, but the dried residue still contains some of the gaseous as well as solid elements.

ANATOMICAL AND PHYSIOLOGICAL CONSTANTS.

(After Huxley.)

Based on an average weight of 154 pounds for a full grown man.

General Statistics.—Make-up of the average body: Muscles and their appurtenances, 64 pounds; skeleton, 24 pounds; skin, $10\frac{1}{2}$ pounds; fat, 28 pounds; brain, 3 pounds; thoracic viscera, $2\frac{1}{2}$ pounds; abdominal viscera, 11 pounds; total, 147 pounds. Add 7 pounds for blood, which will readily drain away from a body, equals 154 pounds. Or, of water, 88 pounds; solid matter, 66 pounds.

Elements making up the solids: Oxygen, hydrogen, carbon, nitrogen, phosphorus, sulphur, silicon, chlorin, fluorine, potassium, sodium, calcium (lithium), magnesium, and iron (mangenese, copper, lead).

Amount lost daily (in grains): Water, 40,000, or 6 pounds; other matters, 14,500; carbon, 4,000; nitrogen, 300; mineral matters, 400.

Organs through which the losses would occur, and amounts (in grains): By lungs—water, 5,000; other matters, 12,000; carbon, 3,300. By kidneys—water, 23,000; other matter, 1,000; nitrogen, 250; carbon, 140. By the skin—water, 10,000; other matters, 700; nitrogen, 10; carbon, 100. By fæces—water, 2,000; other matters, 800; nitrogen, 40; carbon, 460.

Gains to the body: Solid, dry food, 8,400; oxygen, 10,000; water, 36,100; total, 54,500. Losses: Water, 40,000; other matters, 14,500; total, 54,500.

Digestion.—Daily food required: Carbon, 4,000 grains; nitrogen, 300 grains. These might be obtained as follows: Proteids, 2,000 grains, containing 300 grains nitrogen and 1,000 grains carbon; carbo-hydrates, 4,500 grains, containing 1,800 grains carbon; fats, 1,500 grains, containing 1,200 grains carbon; minerals, 400 grains; water, 36,100 grains;

total, 44,500 grains, containing 300 grains nitrogen and 4,000 grains carbon.

Circulation.—Heart beats per minute, 75; amount of blood driven out from each ventricle at each stroke, 5 or 6 cubic inches, or 1,500 grains; rate of movement of blood in the great arteries, 12 inches per second; in the capillaries, 1 to 1½ inches per minute; time required to perform the whole circuit, about 30 seconds; pressure exerted by the left ventricle on the aorta equal to the pressure on a square inch of a column of blood 9 feet high, or of a column of mercury 9½ inches high.

Respiration.—Breathing per minute, about 17 times; residual air contained in the lungs, 100 cubic inches; supplemental or reserve air, about 100 cubic inches; tidal air, 20 or 30 cubic inches; complemental air, 100 cubic inches; vital capacity of chest (*i. e.*, greatest quantity of air which can be inspired or expired), 230 cubic inches. Quantity of air to pass through the lungs per diem, 350 cubic feet; loss of oxygen in passing through the lungs, 4 to 6 per cent. of volume; gain of carbonic acid, 4 to 5 per cent.; amount of oxygen consumed in 24 hours, 10,000 grains; amount of carbonic acid gas produced, 12,000 grains, corresponding to about 3,300 grains of carbon; amount of water exhaled from the respiratory organs, about 5,000 grains, or 9 ounces.

Amount of pure air vitiated to the extent of 1 per cent. in each 24 hours, 1,750 cubic feet, or 17,500 cubic feet of pure air to the extent of 1 per 1,000. Taking the amount of carbonic acid in the atmosphere at three parts, and in expired air at 470 parts in 10,000, 23,000 cubic feet of ordinary air would be required in order that the surrounding atmosphere might not contain more than 1 per 1,000 of carbonic acid. Consequently at least 800 cubic feet of well-ventilated space is needed for a man of this weight.

PART SECOND.

ANCIENT AND MODERN EMBALMING.

CHAPTER X.

ANCIENT EMBALMING.

GENERAL REMARKS.

We are so accustomed to plume ourselves upon the achievements of the nineteenth century, its discoveries and inventions, and its progress in the arts and sciences, that we are often prone to forget its indebtedness to all preceding ages and generations. St. Paul, the great and learned apostle, declared that he was "debtor both to the Greeks and to the Barbarians; both to the wise, and to the unwise." So, likewise, are we of to-day—

> "We the heirs of all the ages, in the foremost files of time."

For every age is the inheritor of the wisdom conveyed through the successes and failures of all its predecessors, and is enabled, by the proper application of such wisdom, to further its own advancement. Forward is the watchword of Time. The earth does not

> "Stand at gaze like Joshua's moon in Ajalon."

Nevertheless, its inhabitants, in their accomplishments, crept before they walked, and walked before they began their grand triumphal march toward great material and intellectual victories—for which march, in these latter days, the music of the spheres themselves seem furnishing the lively quickstep.

In the pride that swells our hearts at the knowledge that we "live and move and have our being," in this age

par excellence of all the æons yet emanated from the Deity, this reflection may beget within us a seemly humility. The present age, that contributes to the world such triumphs of the electrician, bacteriologist, and general scientist, to say nothing of corresponding conquests in numberless other fields and pursuits; that, having found the X ray, proposes to subjugate, therewith, the microbe; that sets no limit to its ambition, and whose bright lexicon contains no such word as "impossible:" has accomplished only that which its forerunners have rendered feasible, when it ceases to speak of "first principles" and presses on to perfection.

In nothing is this tendency to press on toward perfection more clearly demonstrated than the progress which has been made in the art of embalming. What was, in ancient times, a labor attended with much ceremony, delay and many drawbacks, becomes, to the thoroughly-equipped, scientific operator of to-day, a simple task, accomplished in a brief space of time, by the use of a comparatively small quantity of preservative fluid.

The embalmer does not enter our houses heavily laden with hundred-pound weights of myrrh, aloes, saffron and cassia. He is not burdened with opobalsamum—the resinous exudation called balm of Gilead, yielded by terebinthine evergreens of Asia and Africa—; his assistants are not loaded down with gypsum, or bitumen.

Among the distinctive characteristics of the work of our times are skilled, scientific methods and simplicity of detail, which enable us effectually to discard a majority of the cumbersome requisites indispensable to the laborers of bygone ages.

Still, to the forerunner in any field of meritorious performance, is due, of right, that acknowledgment belonging to the pioneer, however convincingly he who comes

afterward may be able to say, "And yet show I unto you a more excellent way."

EGYPTIAN METHODS OF EMBALMING.

It seems peculiarly appropriate that Egypt—that land of mystery—should have been the first, so far as we have knowledge, to embalm the human body after death. Egypt, with its hieroglyphed, cartouched monoliths, mighty pyramidal stairways ascending toward the sky, and grove-shaded temples approached through massive gateways and avenues of sphinxes! Egypt, the land of beauty, bearing olives, dates and citron trees; glowing pomegranates and ruddy-hued guavas; perennially green acacias, papyrus reeds that fringe the stream, and gardens sweet with rose and heliotrope!

The men who reared Luxor and 'graved pictorial history on Karnac's walls and lofty pillars, with so lasting yet so delicate a stroke, must have been beings deeply imbued with sentiments and sympathies of a religious nature. To these feelings, doubtless, may be ascribed their reason for making such an elaborate disposition of the remains of their departed friends. Other assumptions as to the causes from which this custom took its rise have been made, but their credibility fades into insignificance when compared with this. One of these other assumptions is based on the assertion that sanitary expediency was the prompting motive; another, that the periodical overflow of the Nile furnished hindrances to the ordinary form of interment. Still, we cannot but be firmly persuaded that a deeply-rooted, religious belief or superstition promoted this endeavor; their aim being to make the best possible provision lying in their power to secure a happy future for those whom they loved.

Herodotus, the Greek historian, tells us the Egyptians were the first people to believe that the soul is immortal.

In addition to this faith they held that this immortal tenant of the human frame would never fully abandon its place of habitation so long as the body withstood the ravages of corruption. Embalming but emphasized their idea that if the body be kept free from putrefaction, its immaterial tenant would revisit it from time to time, and return to take up its abode once more at the expiration of a certain period. It was a tenet of their faith, that, after death, the soul was compelled to make the circuit of all forms of animal life — bird, beast, and reptile — until it had dwelt for a time in each of them. It then passed through earth, air and water, and after the "circle of necessity" had been completed, returned to its long-empty tenement and entered in. This journey could not be traveled under 3,000 years, and the embalmer's aim was so to preserve the body, that, when such a period should have elapsed, the home-coming soul would find all things in readiness for its reception.

The lengthy and painstaking preparation bestowed upon the body in the embalming of that day speaks well for the estimate of worth the Egyptians placed on the immortal part of man.

It is probable that the embalmers of that period belonged to the medical fraternity, as we read in the fiftieth chapter of Genesis that "the physicians embalmed Israel," the father of Joseph, who died in Egypt. Some writers have objected to this statement on the ground that embalmers were, according to Herodotus, simply persons appointed by law "to exercise this art as their peculiar business." Also, it is claimed, for the reason that such persons were drawn from the ranks of the priesthood. It is easy to reconcile these objections with the Bible statement when it is remembered that Egyptian physicians were a body of specialists. "So wisely," says Herodotus,

"was medicine managed by them, that no doctor was permitted to practice any but his own peculiar branch." The embalmer, even though from priestly ranks, must originally have been compelled to acquire some knowledge of the action of drugs and essences employed in the embalming of the body, upon its organs and tissues. Knowledge of this character may have given him a right to the title of "physician," and license to practice in "his own peculiar branch," as an embalmer.

Immediately after death the body of the deceased was brought to the embalmers by his friends. To these friends were displayed wooden models and painted representations of different forms in which mummies were, so to speak, "done up." A favorite style was that of likeness to the god Osiris, who, in addition to other peculiarities, had the beard cut and arranged in a form belonging exclusively to the gods. All who had lived virtuous lives and were accounted worthy of being finally reunited after death with the god from whom they emanated, were entitled to have their bodies preserved in this likeness and to be called by this holy name. When the pattern was finally agreed upon and the price to be paid for the service about to be rendered determined, the friends withdrew, leaving the subject in the embalmers' hands. Herodotus says the work was begun by removing the brain, through the nostrils, with a curved iron hook or probe, and that the cavity from which the brain was extracted, was then cleansed by an injection of certain astringent drugs with which the skull was filled.

Diodorus does not mention, in his account of the process, the extraction of the brain in this manner; and this statement has met with dissent, on the ground that extraction of the brain through the nostrils would be an exceedingly difficult, if not absolutely impossible, undertaking.

That even if it could have been done, the nose must by this means necessarily have been mutilated and the likeness destroyed; whereas we are informed that "so perfectly were all the members preserved, that even the hairs of the eyelids and eyebrows remained undisturbed, and the whole appearance of the person was so unaltered that every feature might be recognized." Gryphius suggests that the brain might have been extracted through a foramen, or orifice, in the back part of the head, near the upper vertebra of the neck. But, as heads indicating this disposition of the brain have not generally been found in mummies, it gives room for still another theory—that of the injection of cedar oil, or some similar tissue-destroying substance, through the nostrils or ear-passages, by way of an artificial canal prepared for it, and the subsequent coming away of the brain in a state of dissolution. The injection of spirituous or aromatic wines could then have acted as cleansing agents, followed by the final injection of melted bitumen, or sweet balsam, which becomes a solid mass, filling the skull, when cold. Many mummy skulls have been found to be full of earthy matter, in place of either of the above, and some to have been prepared with wax and tannin.

While the care of the head was in process in the hands of one embalmer, other necessary features of the work were assigned to his assistants.

Diodorus says: "First one, who is denominated the scribe, marks upon the left side of the body, as it lies upon the ground, the extent of the incision which is to be made; then another, who is called *paraschistes* (the dissector), cuts open as much of the flesh as the law permits, with an Ethiopian stone, and immediately runs away, pursued by those who are present, throwing stones at him, amid bitter execrations, as if to cast upon him all the odium of this necessary act."

The stone thus made use of was undoubtedly in the form of a flint knife. It may have been called Ethiopian, on account of its black color. Stones used in Egypt for the purpose of cutting were invariably of flint, and were commonly employed by the people. The stone knives found in excavations and tombs, at Thebes and elsewhere, and exhibited in museums of Europe, are of two kinds. One is broad and flat, usually set into some kind of a handle; the other, which is without doubt the knife of the embalmer, is short, pointed, and of razor-like sharpness.

The pursuit of the *paraschistes* already mentioned was probably a religious formality, the people having no real desire to harm him, and he entertaining no actual fear. It indicates, however, that the delicate sentiment which leads modern embalmers to practice their art without spectators, was utterly lacking among these ancient practitioners. In contradistinction to the odium cast upon this knife-user, was the high esteem in which the embalmers themselves were held. They were associates of the priests, and were permitted free access to the temple, as sacred persons.

Through the hole cut in the side of the dead, the lungs, liver, stomach, spleen, and all the organs except the kidneys and the heart, were removed from the body. The latter may have been left as the principal organ and source of vital heat, but it is a matter of uncertainty why the kidneys were not removed. Perhaps some religious superstition determined their being left. The body was likewise divested of the entrails. These, and the cavity from which the organs had been removed, were then washed with Phœnician or palm wine and other binding drugs. The entrails were afterward returned to the body, if not otherwise disposed of, which was sometimes the case, through the sacred eye of Osiris, which was placed

above the incision. This being done, the body was repeatedly anointed with oil of cedar. Myrrh, cassia, aloes and saffron—all fragrant gums and odoriferous spices, with the exception of frankincense, which was consecrated to the worship of their gods—were introduced into the cavity and the body was sewn up.

"After a certain time, the body was swathed in lawn fillets, which were glued together with a kind of very thin gum, and then crusted over with the most exquisite perfumes."

Some historians make no reference to any further preservative process between the use of the aromatics and the binding up of the body in anointed and perfumed linen; but, from others we learn that after the application of the drugs and spices and sewing up of the ventral incision, came the salting of the body. It was kept in natron or anatron, known to chemistry as potassium nitrate, or salt of nitre, and to people in general as saltpetre, an antiseptic used in the curing of meat, for seventy or seventy-two days. This was an arbitrary period to which the embalmers were strictly confined. Upon the expiration of these days, the body was washed and wrapped in linen bandages dipped in oil of myrrh.

Diodorus, who speaks of the actual face of the body being left exposed after restoration, in cartonnage and case, to relatives and friends, is contradicted by Herodotus, who says the features and the whole body were enveloped in wrappings and entirely concealed.

The head was swathed in cloths made fast with flaxen filaments, sometimes of a delicate color. If the body were that of a Pharaoh, or other sacred person, under these filaments were sometimes pushed the stems of lotus buds. The lotus, a name applying to several kinds of water lilies, was a favorite and a sacred flower in Egypt, and was

used in religious ceremonies. It appears in hieroglyphics on Egyptian monuments, and entered into their works of art.

Honorable women of high rank were kept for three or four days after death before being delivered to the embalmers.

In passing, it may be interesting to some to learn the exact nature of the mummy wrappings. The words *byssus* and *linon*, used in describing them, indicate that they were linen, not cotton, although cotton cloth was manufactured in Egypt, and dresses of that material were commonly worn. Sometimes, however, these cerecloths were of finely-wrought silk, and have been known to be over one thousand yards in length.

The above was one of the most magnificent styles of embalming, and was used for persons of quality. Its expense amounted to £250, or about $1,250 in American money. When the usual routine work of embalming had been finished, the mummy was enclosed in a first case, called a cartonnage. This cartonnage was made of pasteboard cut according to exact measurements of the mummied body, and made to conform exactly to its shape, by being fitted upon it when damp, and retaining the bent lines imparted in this way, while in the process of drying. It was richly ornamented with a network of bugles, beads, etc., and the pictured face directly over the mummy's face was sometimes overlaid with gold leaf. Three or four other cases, likewise ornamented and gilded, were superimposed upon this cartonnage, and the whole was then inclosed in a sarcophagus of wood or stone, embellished with painting or sculpture. These sarcophagi were often of cedar or a rot-proof wood called gimmis wood. They were of many different shapes, and the shapes of those fashioned in wood differed from those of stone.

The intestines of all persons embalmed by the most expensive process—for none of the first quality were embalmed without the removal of the intestines—were deposited in four vases of alabaster, hard stone, glass. porcelain or bronze, and these were placed with them in the sarcophagus or tomb. These vases were variously ornamented, usually with the heads of the genii of Amenti. Herodotus does not inform us with reference to what became of the intestines of persons not embalmed as above mentioned. Porphyry says they were thrown into the river. Plutarch gives a similar account and explains the reason for such disposal. He speaks of them as being the cause of all the faults committed by man. The intestines were embalmed in spices, and a separate portion allotted to each of the four vases. In one was contained the large intestine in company with the stomach. In another the small intestine was placed. The lungs and heart. and the gall-bladder and liver, were among the contents of the remaining two.

The most costly of these vases were of oriental alabaster, from ten to twenty inches high, and about one third of the height in diameter. Each bore an inscription embracing the name of the god the likeness of whose head it bore.

In those instances where the intestines were returned to the body, images in wax of these four genii of Amenti were put into the cavity with them. as guardians of those parts subject to their influence. Sometimes, instead, a metal plate, usually of lead, bearing their images. was substituted. The sacred eye of Osiris was placed over the incision whether the entrails were returned to the body or placed in the vases.

Sometimes in the higher grade of embalming. the skin of the face itself, as well as, or instead of, the semblance

on the cartonnage, was covered with a mask of gold leaf. In other instances, the entire body was so overlaid. Sometimes merely the eyelids or the finger nails alone.

Egyptian embalming may be classified under two general heads; those bodies embalmed with the ventral incision, and those without. Under those embalmed with the incision, are classed bodies prepared with balsamic matter and those preserved by natron only. Balsamic embalming was performed with a mixture of resin and aromatics, or asphaltum and pure bitumen. The first named of these bodies—those filled with resinous matter—became of an olive color, the skin dry and flexible, as if tanned, and adhering to the bones. The features remained as in life. The features of those preserved in natron—simply salted and dried—were completely destroyed, and they became unrecognizable. The hair also fell out and the head became bald. But little care was exercised in the bandaging, which scarcely separated the bodies from the earth in which they were interred.

An intermediate grade of embalming, between the most costly and the revolting form above indicated, was the injecting of cedar oil into the abdomen, through the fundament, by means of a syringe. This was done without making a ventral incision, or removing the bowels.

Cedar oil, which possesses heating and drying qualities, also corroded and consumed the substance of the bowels on which it acted. It consumed as well the surplus humidity of the body which brings about putrefaction. Care was taken to prevent this oil's escape while the body was kept in natron during the appointed time. It was then drawn off, bringing with it the bowels upon which it had acted destructively, in a state of dissolution. The natron dissolved the flesh and caused the skin to cling to the bones. The body was then restored to the friends without further

attention. This manner of preserving the dead cost about £60, or $300.

When the dead left no estate and the friends were very poor, the body was simply cleansed with an injection of *syrmœa*, and afterward kept salted in the customary manner for the usual seventy days.

If a stranger were found dead in Egypt, the law required that he should be mummified in the most magnificent and expensive manner.

It is not positively known when the custom of embalming ceased in Egypt. It has been suggested that it may have been when that land became a Roman province. It is probable that after this time embalming became less universal and gradually fell into disuse, rather than that it was suddenly abandoned. After the sixth century, interest in this disposition of human bodies declined so sensibly that only a few of the more studious and scholarly were informed of the real secret of the art.

A description of Egyptian tombs, with their artistic adornments, the mummy pits with which Egypt is honeycombed, and the funeral customs there observed, would be of interest to the curious inquirer concerning Egyptian antiquities, but such description would form a lengthy article of itself, and does not, strictly speaking, come within the province of this article.

JEWISH METHODS.

The Jews adopted the custom of embalming to some extent, the "manner of the Jews" being to employ "linen clothes with spices" in winding the body. When Lazarus was resurrected by the Savior's command, "Come forth," he appeared at the aperture of the tomb, "bound hand and foot with grave clothes, and his face was bound about with a napkin." But by whatever process his body may

have been prepared for the sepulture, it is evident that his sister Martha did not believe it sufficient to preserve it effectually and with thoroughness; for, when Jesus had said to the bystanders, "Take ye away the stone" that obstructed the mouth of the cave, she had protested, declaring, "Lord, by this time he stinketh, for he hath been dead four days." So hampered was Lazarus by the wrappings in which he was swathed, that, though life had returned to him, he was unable to make use of his renewed vitality until the authoritative mandate, "Loose him, and let him go," had been obeyed.

Jacob, who died in Egypt, was probably embalmed after the Egyptians' most expensive and elaborate manner, for Joseph, who "commanded the physicians to embalm his father," was high in the royal favor—"the man whom the king delighted to honor." When Joseph went up to the land of Canaan to bury his father, "with him went up all the servants of Pharaoh, the elders of his house, and all the elders of the land of Egypt."

Probably this same form of embalming was used with Joseph, when "he died being an hundred and ten years old; and they embalmed him and he was put in a coffin in Egypt." Before dying, he "took an oath of the children of Israel saying, God will surely visit you, and ye shall carry up my bones from hence."

Wherever the body of Joseph was kept, whether in an apartment of a house, according to the usage of some of the Egyptians, or in a tomb prepared for it, this oath was strictly fulfilled by the descendants of those who made it, nearly two centuries afterward, when the Israelites returned to their own land.

This custom, here referred to, of keeping the mummied body, for a long time, in a place set apart for it in the former home of the person deceased, was sometimes

permitted; but some specious reason was usually assigned in excuse for it, as it was considered a very grave thing to deprive one entitled to it of the right of burial. No grief and shame could be more terrible to surviving friends than to have departed dear ones, by a verdict rendered after post-mortem judgment, which was common in Egypt, accounted unworthy of burial.

The poor among the Jews, those known as the "common people," were embalmed with bitumen, which was a cheap material, easily procured. It was a mineral pitch found in large quantities on the shores of the Dead Sea, which for this reason was also called the Asphaltic Lake. This lake was located in Palestine, about one hundred miles from Damiata in Egypt, and the bitumen used by the Egyptians came from this place. The body and its envelopes were smeared with this substance "with more or less care and diligence." This bitumen must, however, have possessed considerable preservative power, as sepulchres have been opened in which thousands of bodies deposited in rows, one above another, without coffins, have been kept from decay for centuries, by its use. Coal tar, petroleum, and naphtha are of the same derivation. Mummies prepared by this substance are, of course, black, hard and shining. The skin appears as if varnished. They are dry, heavy, and without odor. But the more usual form of embalming, among the Jews, appears to have been made use of more to perfume the body and keep at a distance as long as possible, the disagreeable odor which belongs to death, than with the expectation that it would for any great length of time ward off putrefaction. It was simply the binding of spices upon the limbs and body with the usual linen bandages.

In this manner, at the near approach of the Jewish Sabbath, which must not be defiled by the presence of the

unburied victims of the law, Jesus, when taken down from the cross where he had suffered for the sins of the whole world, was ministered unto by Joseph of Arimathea, a secret disciple, and Nicodemus, who "brought a mixture of myrrh and aloes, about an hundred-pound weight." When the Sabbath was over, very early on the first day of the week, came the faithful women who had loved and followed him, with spices and ointment they had prepared wherewith to anoint him, not knowing that, already, this loving service had been performed by the hand of pious affection.

But even in this simple style, embalming was not, it appears, a prevalent mode of disposing of the dead, among the Jews.

METHODS OF THE ROMANS AND OTHER NATIONS.

The funeral rites of the Romans and many other nations embraced embalming in some form. The deceased after being washed in hot water, sometimes varied with oil, every day for seven days, to revive him in case he was simply in a condition of suspended animation, was "dressed and embalmed with the performance of a variety of singular ceremonies." After this his body was placed on a funeral pile and burnt. The ashes were then gathered into a vase or urn, and deposited in the tomb.

The Babylonians made use of honey in anointing their dead, or immersed them in this viscid fluid. The Scythians immured the body in a coating of wax. The Ethiopians washed it over with a sort of plastering called parget. Embalming also was practiced among the Persians, Assyrians, and many other ancient nations. The Greeks acquired the art through their conquests.

The Guanches, the original inhabitants of the Canary Islands, probably obtained the custom of embalming their dead from the Atlanteans who inhabited the famous "lost

E.—7

Atlantis," an antediluvian island or continent which the ancients asserted was overwhelmed and swallowed by the "great deep." These islanders coated the body with a liquid composed of a solution of resinous matter in an oil or volatile liquid—a sort of varnish—, after which they wrapped it in goat skin and placed it in a wooden case.

ON THE WESTERN HEMISPHERE.

Without doubt, the aborigines of the Western Continent were familiar with the practice of this art. The early Peruvians. we learn from accounts contained in Prescott's "Conquest of Peru," preserved the dead body of the royal Incas by some marvelous process which did not give evidence of foreign applications, and secreted them under mounds of earth and in the interiors of their temples. He presents an ancient picture of these embalmed Peruvian monarchs sitting "natural as life, in chairs of gold," in the temples of the sun, at Cuzco. They were clothed in their accustomed princely attire. The raven-black or silver-gray of the hair on their bowed heads was still unchanged, and their hands were crossed upon their bosoms in the grim dignity of death.

The Aztecs, a highly civilized race, and one of the most interesting and powerful of the indigenous tribes of America, inhabiting the plateau of Anahuac—later known as Mexico—, who were conquered by Cortez in 1519, and whose history has been traced back to the twelfth century, made careful preservation of the bodies of their dead, especially those who could lay claim to royal descent.

Aztec legends relate how, after the deluge, seven persons issued from the tomb to which their mummied bodies had been committed, and, in renewed existence, repeopled the earth.

The art was not unknown among the early North American Indians. Mummies remarkably well preserved

have been found among the Flatheads, Dakotas, and Chinooks; and the Florida and Virginia Indians so preserved the bodies of their kings. Quite a number of good mummies have been found in Kentucky caves.

AMONG EARLY CHRISTIANS.

The early Christians, for a time, embalmed their dead, according to those forms with which they were familiar in Palestine. No special reason, so far as we have been able to determine, has been given for their abandonment of this ceremony. It may be inferred that they feared, by its continuance, to cast discredit upon the power of God to call together the scattered dust of the body which had returned to its native element, and present it like unto Christ's "own glorious body" on the morning of the resurrection. But, if so, in this they erred.

When the Creator stated to Adam, "For dust thou art, and unto dust shalt thou return," he put forth a simple statement of fact; it was not the issuance of a command.

No word was ever spoken by Jesus indicating his disapproval of attempts, with which, as a Jew, he was fully familiar, to preserve the body from decay after death. St. Paul, the greatest of the Christian apostles, inquired of the Corinthians: "What! know ye not that your body is a temple of the Holy Ghost which is in you, which we have of God and ye are not your own?" Men preserve with care, in original grandeur and dignity, the palace where an earthly king has dwelt, and the inn where some mighty man has tarried for a night. Shall they let this temple of the "King of Kings" become dishonored so long as preservation is a possibility? Shall they willingly give it over to decay and corruption?

No; let us care for the body, made in God's own image, while we live; and let our friends, in recognition of the

temple it has been — of the soul and its Creator —, give to it all the deference they can offer, when we shall have passed on to dwell in it no more,

> "Until the morning's happier light
> Its glory shall restore,
> And eyelids that are sealed in death
> Shall wake to close no more."

CHAPTER XI.

MODERN EMBALMING.

Great progress has been made in embalming during the present century, and earlier methods have given way to more modern and enlightened ones. Which one of the early modern embalmers justly merits the title of father of the present system, matters but little, for like every form of advancement it has had growth and development, and the methods of none of these forerunners have survived, at least in this country; only their investigations led in new channels, resulting ultimately in the prevailing methods.

The processes explained in this chapter are exclusively European.

Dr. Frederic Ruysch, who occupied the chair of anatomy at Amsterdam, Holland, during the closing third of the seventeenth, and early years of the eighteenth, century (1665–1717), was probably the first to practice a successful system of arterial injection, which, however, he used only in preparing specimens for his anatomical work. He did not stop with a simple injection of the arteries, but, after permitting the body to remain for some hours to allow a diffusion of the fluid through the structures, he proceeded to lay open the body as in making a post mortem examination. The viscera of the chest and abdomen were removed, and the fluid in them sponged out. The organs were then steeped in spirits of wine, replaced, and covered

with a preservative solution. He brought his method of preserving dead bodies to such extreme perfection that his specimens were the wonder of his generation, and indeed of later ones. Peter the Great, who was among the distinguished personages to inspect his work, possibly paid the highest compliment to his art, by kissing the life-like lips of a child, preserved by the great anatomist, without at first discovering the fact that the lips were those of the dead. Dr Ruysch's method is said to have preserved the natural color of the body, as well as the form and suppleness of the limbs. He left behind him at his death a large assortment of injected portions of the human body, but no specimen of the body entire. Peter the Great secured a large portion of these specimens, which he carried to St. Petersburg. Whether or not the Ruyschian method was as perfect as claimed for it, or whether some of the statements concerning it should be largely discounted, the brilliant anatomist was the first known arterial injector, as well as one of the most skillful of any age. However, he neglected to take the world, or other scientists, into his confidence; hence, but little if anything is known as to the chemicals used by him, or the manner of their injection. His discoveries were, consequently, lost to science. For this reason, others, whose methods were published to the world, have been considered by many as better entitled to the honor naturally accruing from a great discovery.

Dr. William Hunter, an eminent Scottish physician, anatomist and physiologist of the last century (1718–1783), is by many given the credit of being the original inventor of the injection method. Unlike Dr. Ruysch he published his plan of injection in minute detail. The artery usually selected by him was the femoral. His solution was composed of oil of turpentine, five pints; Venice turpentine, one fluid pint; oil of lavender, two fluid ounces; oil of rose-

mary, two fluid ounces; and vermillion. This was forced into the vessels until it reached over the whole body, giving the skin a general reddish appearance. As in Dr. Ruysch's method, complete diffusion of the fluid, through the minute vessels of the body, was secured by leaving the body untouched for a time. The body was then opened, the thoracic and abdominal organs were removed, emptied, and cleaned, their vessels injected with the fluid, and the organs steeped in camphorated spirits of wine. The cavities were washed with the camphorated spirits, the viscera were replaced, and the intervening spaces were filled with a powder composed of camphor, rosin and niter. This powder was also placed in the mouth, nostrils and other external cavities, and the body was rubbed over with essential oils of rosemary and lavender. The final operation consisted in placing the body thus prepared in a coffin upon a bed of dry plaster of Paris, placed there to extract all moisture from the body. The coffin was then closed for four years, when it was opened. Another bed of the plaster was added at that time, in case desiccation had not been complete.

John Hunter, a younger brother of William, was but little less renowned along the same lines, and also helped greatly to advance the science of embalming, devoting much attention to experiments with various preparations.

Some of the most perfect specimens of modern embalming to be seen to-day are Hunterian, and are found in the museum of the Royal College of Surgeons, London. One is the body of the wife of the eccentric Martin Van Butchell, preserved, some authorities say, by Dr. John Hunter, by the injection of camphorated spirits of wine, etc., into the arteries and veins. Other, and probably more creditable, authorities, ascribe the work of preservation to the older brother. and declare that the method

used was the same as the one so fully outlined above. Another body preserved in this museum was that of a young woman, who died about 1780, in the Lock Hospital, of consumption.

The Hunterian Method was practiced with or without modification by many succeeding British anatomists. Dr. Matthew Baillic, instead of removing the intestines or other viscera, injected the preserving fluid into the stomach, rectum and lungs, after having made a complete injection of the arterial system. Dr. Sheldon used as his preservative fluid, camphor dissolved in spirits, in the proportion of one ounce of camphor to six of spirits. He removed the viscera and coated them and the visceral cavities with tar, enveloping the body with a tarred sheet. His method is said to have been successful. Joshua Brooks, the last of the great English anatomists having a distinctive school of anatomy of his own, practiced the Hunterian method with but slight if any modifications.

M. Boudet's process was a modification of the Egyptian, he being one of the last to follow ancient methods as well as the first to use corrosive sublimate as a preservative. He embalmed with tan, salt, asphalt, and Peruvian bark, camphor, cinnamon, and other aromatics, and corrosive sublimate. He also completely enveloped the body in bandages, varnish being coated over the body and cavities and outer bandage.

M. Franchini's process consisted of injecting the arteries through the common carotid artery with a solution consisting of eight decigrams of arsenious acid combined with a small quantity of cinnabar, dissolved in nine kilograms of spirits of wine. By this method bodies could be kept odorless and natural in color for sixty days, after which they began to desiccate, and would mummify so as to last for all time. He had previously used a substance

which had to be reduced to a fluid by heat and which became hard when cooled. This was given up for the simpler method outlined above.

Jean Nicholas Gannel (1791–1852), a shrewd and progressive French chemist, introduced a new system of merit in the 30's of this century. Indeed several methods bear his name, for he used different preparations at different times. He claimed to be able to preserve a body for five or six months by using acetate of alumina, which he obtained by decomposing the sulphate of alumina and potassa by the action of acetate of lead, using five or six liters of this acetate of alumina of a density of 18° (Beaumi's areometer) to a body. He was also able to preserve a body thirty to sixty days by using a solution of one kilogram of sulphate of alumina to five liters of water. In injecting he used one of carotids, injecting downwards. Later he found it necessary to open the abdomen, in order to relieve the stomach and bowels of gas. M. Gannal's secret formula, which he claimed contained no arsenic, on being analyzed by a governmental commission, was found to contain that substance. Embalming with arsenious solutions having become common in France in Louis Philippi's time, the government interfered and prohibited the sale of arsenic and all compositions containing it for embalming bodies, as well as for several other uses. The further use of M. Gannal's solution was therefore stopped. This prohibited solution was formed by saturating forty liters of water with five hundred grains of arsenious acid, and dissolving therein by heat equal parts of sulphate and acetate of alumina, until the liquid attained a density of 20° (Beaumi's areometer).

M. Sucquet, in a contest before a board of prominent French physicians, in which MM. Gannal, Dupre and others

participated, won a signal victory for his method, using a nonarsenic preparation. His solution was composed chiefly of chlorid of zinc, which he injected arterially. M. Dupre made use of carbonic and sulphurous gases and M. Gannal injected a solution composed of equal parts of the sulphate and the chlorid of alumina, at a density of 34°. Bodies prepared according to these processes, in the presence of the body of physicians mentioned, were buried for fourteen months, when they were disinterred in the presence of the same commission. M. Gannal's subject was found to have undergone putrefaction, while the one prepared by M. Sucquet was in an excellent state of preservation. The latter body, on exposure to the air, without showing any signs of putrefaction, dried to a state of hardness, little short of that of wood or stone. In consequence of the remarkable success of M. Sucquet's method, it came into extensive use on the continent of Europe and to a considerable extent in this country.

M. Falcony had a desiccatory process which mummified the body, gave it a yellow appearance, but well preserved it, without any mutilation or injection, by simply placing the body in a bed of dry sawdust to which powdered zinc sulphate had been added. In a paper read before the French academy, he said he found, after careful tests with different salts, that zinc sulphate of different degrees of strength, according to the condition of the body, weather, etc., to be the best preservative material; that a gallon would perfectly preserve a body. Bodies so preserved remained flexible for forty days, after which they began to dry up, though still retaining their natural color. Others practiced this system with remarkable success.

Dr. Chaussier's method, as given in Thenard's Chemistry was in brief, as follows: The body completely emptied and thoroughly washed, was kept constantly

saturated with corrosive sublimate. The salt gradually combined with the flesh, giving it firmness and rendering it imputrescible and incapable of being injured by insects or worms. The author states that he has seen a head prepared in this manner which had been exposed for several years to the alternation of sun and rain without suffering change, and was easily recognized, though the flesh had become hard as wood.

Franciolla's method was not greatly different from some of the others given. The formula used by him was as follows: Arsenious acid, four ounces; carbonate of potash, two ounces; powdered alum, eight ounces. The acid and potash were dissolved by boiling in three quarts of water, the alum added, and the whole diluted by the addition of water until it made one gallon of the preparation. He opened the abdomen, emptied the stomach and other organs, washed, dried and injected them; then injected the bronchial tubes by puncturing the trachea. For arterial injection the right common carotid artery was selected, the blood being removed from the veins by puncturing the inferior vena cava, a little below the renal vein, and the jugular vein. The blood was let out of the vena cava before the abdomen was cleansed, and was removed by a sponge or pump. After injecting the head and neck, Franciolla turned the injector downward and continued the injection until completed. Later in his practice he selected the splenic artery for injecting. He poured a solution over the bowels before replacing them; a strong solution of bichromate of potash being sometimes used, though not with the best of satisfaction. He also advocated filling the abdominal and thoracic cavities with a liquid preparation of cornstarch, water, alcohol and corrosive sublimate, which, after hardening, would prevent the sinking of the parts.

Brunetti, another Italian, used a method, which, it is claimed, preserved bodies so that they resisted decay for hundreds of years, but they became hard as stone and were of course useless for anatomical study. They, however, retained their form and size in a remarkable degree. By this process the circulatory system was thoroughly cleansed by washing for from two to five hours with cold water, until it issued from the body looking clear. Alcohol was then injected to remove the water, and sulphuric ether to carry out of the system all fatty and greasy substances, these operations occupying five to ten hours. Equal time was spent in injecting a strong solution of tannin, after which the body was dried by means of a current of warm air which had been passed over heated chlorid of calcium.

A Method in Vogue in Belgium has proven quite successful, though the process is tedious and requires considerable time for the preparation of the body. The preserving fluid is composed of the following ingredients: One-half pound each of alumina and sulphate of alumina and one ounce of corrosive sublimate, dissolved in one gallon of water. The body is first thoroughly washed with soap and tepid water to remove every particle which might obstruct the pores of the skin, for the process depends largely upon absorption of the solution through the pores. After the body has been thoroughly dried by the vigorous use of clean towels, the solution is applied externally, keeping the body moist. The application must be renewed from time to time as absorption and evaporation lessen the supply. The theory of this part of the process is to keep the body as nearly as possible completely immersed. The stomach and intestines are removed through an incision in the abdomen and thoroughly cleaned. Blood is withdrawn from the system by opening the inferior vena cava, and the arteries are injected through the

abdominal cavity. The diaphragm is punctured and the pleural cavities are filled with a solution of arsenite of soda.

Dr. Tscheirnoff's method was as interesting as it was thorough, but its necessary expensiveness was fatal to its general use. The mutilation of the body, incident to this method, also detracted from its popularity. He first opened the abdomen by making an incision extending from the sternum to the umbilical region, with a short cross incision about midway. This gave a diamond-shaped opening exposing the abdominal viscera. Entrance to the thoracic cavity was gained by carefully cutting the ribs loose from the sternum and turning the latter back over the face. This exposed to view the heart, lungs and aortal arch. The next step was to displace the bowels and sponge out all fluid or serum found around the intestines. The intestines and other internal organs, whose contents were liable to putrefaction, were emptied, the bladder being vacated through the urinary canal by means of a catheter; after which they were injected with fluid. He then injected the arteries through the descending aorta, which was exposed by moving the small intestine to the right, to be replaced on completion of the operation.

This did not complete the surgical part of the process, for the back of the skull was trepanned, making a two-inch circular hole, through which the brain, or as much of it as could be reached, was removed by means of a long-handled, slender, specially-made spoon. This cavity was filled with a thin paste made by fully saturating a half gallon of water with alum, and thickening to the proper consistency by the addition of plaster of Paris; the wound was then carefully closed and sewed up. The thoracic and abdominal cavities and their contents were washed and dried and the viscera surrounded with tannic acid.

The sternum was then replaced and the wound temporarily closed, and the body completely enveloped in a sheet saturated with fluid, in which condition it was left for twelve hours. The envelop was then removed, the cavities of the thorax and abdomen reopened, and the plaster of Paris and alum paste, mentioned above, was poured over and around the viscera, filling all the space to the level of the ribs. After the paste set tannic acid was sprinkled over the top, the sternum was replaced and the wound permanently and carefully sewed up. The inside of the mouth was filled with cotton saturated with embalming fluid in order that the face should retain its fullness; the nose cavity was also filled with paste. The entire body was finally coated with a preparation of Canada balsam and turpentine, which is transparent and excludes the air.

The Florentine Process of embalming, used chiefly for the preservation of subjects for the dissecting table, as described by Dr. Venali, an Italian authority on the subject, was somewhat like Dr. Tscheirnoff's. The abdomen was opened by a transverse incision across the body, the stomach and intestines emptied of any gaseous, liquid or solid contents, and then injected; the cavity cleaned, sponged, and sprinkled with tannic acid. The thoracic cavity was entered from the abdomen, through the diaphragm and similarly treated. Arterial injection was made through the femoral artery, the opening being made about eight inches from and below Poupart's ligament.

A German Process of preservation, which, when properly followed, has kept bodies so perfectly that they retained their form, color and flexibility, so that, after a period of several years even, they made good subjects for purposes of dissection, and were free from offensive smells. The formula for the preserving fluid is as follows: In 3000 grams of boiling water, dissolve alum, 100 grams; sodium

chlorid, 25 grams; potash, 60 grams; arsenic acid, 10 grams. This solution is then cooled and filtered to 10 liters, when 4 liters of glycerine and one liter of mythylic alcohol is added. Bodies are injected arterially and saturated with the liquid, 8 or 10 liters being used to a body, according to the size and condition.

Embalming but Little Practiced To-day in England.—Singularly enough, while the English, in the later portion of the last, and first of this, century, made such wonderful progress in embalming, the art is but little practiced to-day in that country; and then generally for others than natives of Great Britain—especially Americans. The late Dr. Benjamin Ward Richardson, F. R. C. S., in his work on "The Art of Embalming," said:

> Embalming at the present day is, in England, an exceptional process, and when we are called upon to perform it here, it is, in ninety-nine cases out of the hundred, for some one foreign to our country. I have embalmed fifty bodies, but only in two or three instances the bodies of English people, and in these exceptional instances the deceased, although they were born and died in England, had lived the greater part of their life abroad, and were embalmed in order to be conveyed to friends at a distance, who wished to bury them.

A recent letter from Mr. Halford Lupton Mills, Cambridge Place, Norfolk Square, Paddington, London, West, who is said to be the only British undertaker holding a diploma from an American School of Embalming, reaffirms this statement from both personal experience and observation.

CHAPTER XII.

UP TO DATE EMBALMING.

INTRODUCTORY REMARKS.

In the last chapter we treated wholly of European methods and processes; in this and succeeding chapters we take up the latest and most approved practices in vogue in this country.

The methods of to-day, especially as practiced in America, are far in advance of those of three thousand years ago, or indeed of any processes that have been practiced in the distant or more recent past. We do not eviscerate, nor make any indecent exposure of the remains; and we accomplish in a few hours what our old friends, the Egyptians, required days and weeks to perform. Our modern methods, simplified by our modern instruments and appliances, place us in a position where comparisons with the crude work of the Egyptians would be odious.

Prof. Charles W. McCurdy, Sc. D., Ph. D., in his recently published thesis on "Embalming and Embalming Fluids," has well said:

> In fact, the methods of embalming as taught and practiced in the present, demand a higher order of intelligence, a more thorough knowledge of the anatomy of the body, a steadier judgment, and a more skillful hand than was at any time required of or presented by the ancients who relied largely upon atmospheric influences for the preservation of their dead.
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> * * * * * * * * *
>
> Were modern embalmers so disposed, I have no doubt they could attain to the preservative excellence of their ancient brethern, indeed

far surpass them, and prepare our dead for the judgment day; but embalming, except for temporary convenience, as a rule, is not deemed desirable here or in Europe; and, as it forms no part of the theological system of Christian nations, we have no ambition to rival them in mummification.

Dr. Thomas Holmes, of Brooklyn, New York, is, without doubt, justly entitled to the honor of being called the "father of embalming" in this country. During our late war Dr. Holmes embalmed many bodies for shipment to their friends, to be buried in the cemeteries near their old homes, instead of being left to molder in the clay in alien soil.

Embalming is practiced to-day chiefly for two reasons, viz: that of preservation and that of sanitation. Other minor reasons may be advanced, but these are the principal ones.

PRESERVATION AS A REASON FOR EMBALMING.

In performing "the last sad rites" over the dead, the period of mourning prior to interment usually lasts from two to four days, and, in case of a shipment, sometimes it is prolonged for months.

Previous to the introduction of embalming as practiced to-day in this country, the undertaker, or whoever took charge of the funeral, usually had to handle a putrefying mass of animal tissue, sometimes in a horribly corrupt state, and always with more or less putrid odor. The introduction of ice modified these results to a certain extent, but all localities were not blessed with that precious product. Therefore, with the growing demand for more expensive funerals, came the great desire for a better and more general means of preserving the body until interment could take place. In case shipment of the remains to some distant point is desired, embalmment is to-day considered absolutely essential.

SANITATION AS A REASON.

Sanitation as a reason has been considered secondary, but it should not be so. Every body dying from contagious or infectious disease should be embalmed, for the purpose of destroying the germs of contagion and infection.

The health-boards in every state, county, city or town, should make it incumbent on every person or persons who inter bodies dying from cholera, yellow fever, smallpox, diphtheria, typhoid fever, or any other infectious or contagious disease, to embalm them thoroughly with a fluid that contains the strongest disinfectants. It would lessen the danger in our own, and be a great safeguard to future, generations. Cemeteries are being changed and bodies are being disinterred at all times. Our water supplies are liable to become contaminated by water running through, or having their origin in or under, a cemetery. The spores of contagion of the bacteria are not destroyed for a long period of time by earth or water. Consequently running water may take them up and convey them to any distance, thus spreading disease. Therefore, embalming, under the circumstances, would be of inestimable value as a sanitary measure.

THOROUGH EMBALMMENT.

The Condition, Appearance and Disease of the Body to be embalmed should be taken into consideration before commencing the operation. The disease that caused death; the time that has elapsed since death occurred ; the presence or absence of rigor mortis ; the appearance of discoloration and the presence of gases — putrefactive or otherwise — in the tissues or cavities, will govern the operation of embalming entirely.

If the disease has been a simple one, the length of time since death but a few hours, no gases nor evidence of

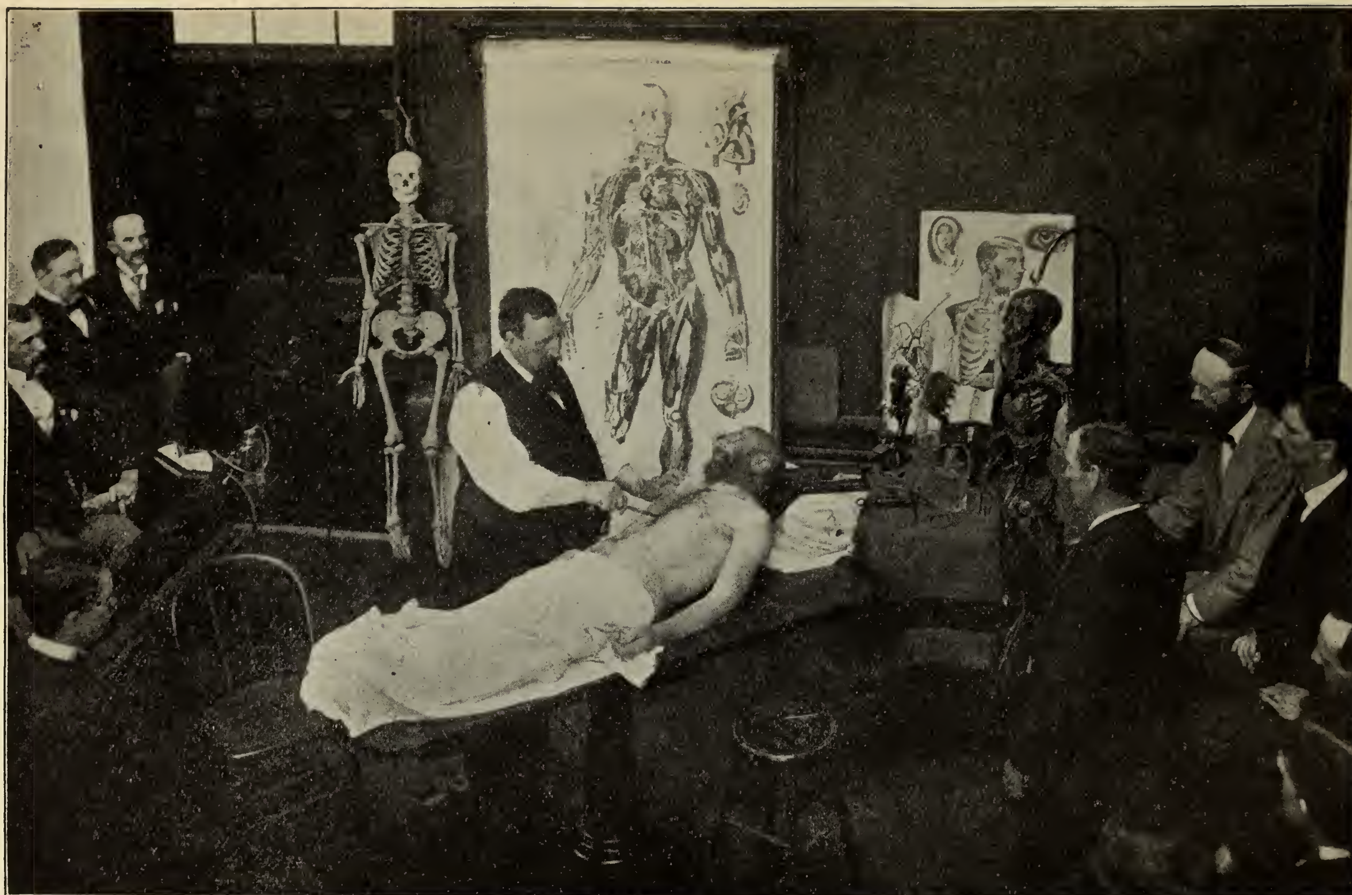

Fig. 13.—BEGINNING A DISSECTION.

putrefaction present, the operation can proceed at once, after placing the body on the embalming board with the trunk and head elevated. Next select the artery for injection and raise it as directed under the proper heading; withdraw the blood and inject fluid sufficient to fill the capillaries. Then fill the stomach, through the esophagus, and the lungs, through the trachea. Also, inject the chest and abdominal cavity with fluid. If rigor mortis is present break it up as much as possible before beginning the operation. Special diseases will be treated under separate headings.

To Thoroughly Embalm a body fluid should be injected into every tissue of the body, through the arterial system, because it reaches every part of the body by way of the capillaries. Also, fluid should be injected into every subdivision of, and into and around, every visceral organ contained in the two great cavities of the body, and into the mouth, nose, gullet and trachea. Blood should be withdrawn from the vascular system, and the cavities relieved of gases and morbid matter. To inject fluid only through the arteries, in many cases, is not sufficient. The circulation may be obstructed by clots, calcareous deposits, contractions or aneurisms, thus preventing a proper distribution of the fluid. There may be more or less morbid material in some of the visceral organs, or effete material in the alimentary canal, the home of the bacteria of putrefaction. Fluid should be mixed with this material by cavity injection as well as to fill the tissues of the walls of the cavities containing it, by the arterial injection. One method should not be practiced to the exclusion of the other. True, some cases can be preserved by either one of these methods, when used alone. But this is no reason why the other should be excluded. If a body dying from typhoid fever is injected by the cavity method alone, it

may be successfully preserved, but the infectious bacteria will not be destroyed in the other parts of the body. As a sanitary measure every body should be thoroughly embalmed, and a rule should be adopted by every board of health to enforce it.

Appearance of a Body After Thorough Embalmment.—Owing to the chemicals contained in the fluid that has been injected into the body, changes in the appearance of the surface will likely manifest themselves within a few hours after death. A lifelike appearance will follow the introduction of some fluids, while a marble-like whiteness, a brownish tinge, or a leadish-like tinge, will follow the use of others. In some bodies the above changes do not take place at all.

These changes will indicate that the fluid is having an effect upon the rete mucosum and dermis only, and not that the body will keep forever—as some would have you believe. Neither does it indicate in those bodies where the changes do not take place, that a second injection should be resorted to, to keep them the "usual length of time." The rule is that ordinary cases do not require a second injection, but an exception will occasionally occur. Very frequently special cases, such as septicæmia, consumption, typhoid fever, peritonitis, morphine cases, etc., require a second, or even a third, injection. Cases to be kept indefinitely such as those that are to be shipped, those to be kept for identification, those to be placed in family vaults, etc., should receive a number of injections.

CHAPTER XIII.

DEATH: ITS MODES, SIGNS AND CHANGES.

Modes of Death.—Whether death results from natural decay, disease, or violence, the proximate causes may be reduced, when fully analyzed, to two, namely, cessation of the circulation and cessation of respiration. On the continuance of these functions depends the life of the whole body, or any part of it. Their functions may stop from causes operating directly on their mechanism, or by causes operating indirectly through the nerve centres which regulate them. Hence it is usual to describe the latter as the third mode of death; so that we speak of death being produced by the cessation of the function of any one of the three organs: the heart, the lungs, or the brain.

Signs of Death.—It is not always easy to determine when life is extinct. We have no single positive sign of death. We usually combine several signs to determine when the spark of life has become finally extinguished.

Syncope, Asphyxia and Trance are the conditions which most resemble actual death.

Cessation of the Heart's Action.—Proof of the cessation of the heart's action is the most reliable sign of death. Mere pulselessness is not proof, for the heart may be still beating, and resuscitation may be possible. The stethoscope should be used skilfully over the region of the heart. There should be no hurry; continue the auscultation

for some minutes, or even a half hour, if the case is a doubtful one.

In hybernating animals during the hybernating period the pulse is slow and feeble — only eight or ten beats per minute — but during activity the rate is eighty or ninety per minute. A similar condition may exist in man.

The cases of Colonel Townsend and of the Indian fakirs, referred to as examples of the cessation of the circulation, while life still remained. were not scientifically investigated. and are to be set down as "fakes."

Magnus recommends the application of a tight ligature on a finger or toe. If the circulation has ceased entirely, there will be no change in color; but if there is any circulation at all, it matters not how feeble, the extremity sooner or later assumes a bluish tint, from strangulation of the venous flow.

If cessation of the heart's action is absolutely established, other signs may be ignored.

Cessation of Respiration. — Respiration may appear to be suspended, but still it may be going on. The test for moisture, by holding a cold mirror over the mouth and nostrils; placing a flock of cotton wool on the lips to test for air currents; and observing whether the reflection on the surface of a cup of water placed on the chest moves or remains still, are all well adapted for the detection of respiration. If the results are all negative the indications are that respiration has ceased.

If death is present, the skin becomes ashy pale, and the tissues loose their elasticity. Tension of the eye becomes less, and the cornea becomes opaque. The pupils fail to react to light. Irritants applied to the skin do not cause vital reaction. Certain parts may retain their independent vitality after somatic death, though the body be dead as a whole. The muscles may be made to contract, by

the application of an electrical current, two or three hours after death.

The following changes in the body not only indicate death, but aid in fixing the probable time at which death occurred:

Cooling of the Body.—After death the body dying from ordinary disease becomes cool gradually. If placed in an average temperature without clothing it will cool at the rate of about 1° Fahrenheit per hour. A thick coating of adipose tissue, as found in fat, heavy people, clothing, etc., retard cooling.

The superficial coldness of collapse, which is due to cessation of the peripheral circulation, must not be taken for cadaveric coldness, for there is still considerable internal heat which must pass off, and the body, cold to the touch before death, may after death rise in temperature, as the internal heat radiates.

Hypostasis.—After death the blood gravitates to the dependent parts of the body, giving rise to livid discolorations, termed hypostasis. These discolorations are liable to be confounded with ecchymoses or extravasations of blood, but they differ from ecchymoses in the fact that the blood is contained in the vessels and not extravasated into the tissues, as may be shown by an incision into the skin. If the blood remains in a liquid state, these discolorations may be made to disappear if the position of the body be reversed, but they will reappear in the other parts that are now most dependent. They usually occur in from eight to ten hours after death.

Post-Mortem Staining.—While hypostasis is making its appearance, other important changes are taking place on the upper surface of the body. The blood undergoes the earliest and most rapid change. The hemoglobin escapes from the red corpuscles, partly by exudation, and

partly by the destruction of the corpuscles themselves, being dissolved in the liquid of the blood and passing through into the surrounding tissue, causing a staining of the tissue, known as post-mortem staining. This staining is of a uniform pinkish-red color, and must be distinguished with care from the redness of hyperæmia, which appears only in points or layers. The amount of staining is in proportion to the amount of blood and the rapidity of decomposition.

Rigor Mortis.—Arrest of nutrition is accompanied by a state of rigidity in the muscles, known as rigor mortis, or cadaveric rigidity. It is due to coagulation of the muscle plasma. This rigidity usually begins in the muscles of the neck and face, and gradually extends from above downwards. Putrefaction begins in the same region and follows in the same order, so that while the upper parts of the body appear flaccid, the lower extremities are rigid. This rigidity can be broken up and it will not return. If cataleptic rigidity is broken up it will return. Mobility is still observable at the joints to a certain degree. Not so in the stiffness of freezing where all parts are equally rigid and crackle if bent. Rigor mortis takes place in all bodies after death. The muscles become firm and shortened, apparently in a state of chronic contraction. It comes on at once after the muscles have lost their irritability. The time of its appearance and its intensity depends upon the state of muscular nutrition at the time of death. The greater the store of muscular energy at the time of death, the longer it is before rigidity sets in, and the longer it lasts. On the contrary, the greater the exhaustion the sooner rigidity sets in, and the sooner it passes off. Rigor mortis is longer appearing in subjects dying in vigorous health, as by accident, than in those dying from exhausting diseases, as consumption, etc. In cases of full muscular

vigor the rigidity will come on in from one to twenty-four hours and last from one to ten days, while in those of exhaustion it may come on at once and last only a few minutes.

Putrefaction is effected by micro-organisms, known as saprophytes, or putrefactive bacteria. When rigor mortis passes off, decomposition begins. The tissues undergo decided changes. The first external indication is a greenish discoloration over the right inguinal region. Internally the mucous membrane of the larynx and trachea is the first to change in color and consistence. The discolorations are due to alterations in the transuded hemoglobin. The less compact tissues are the first to putrefy, the fibrous tissue resists for some time longer, and the compact tissue of the womb resists putrefaction longer than any other. In the course of time all the soft tissues disintegrate entirely and the skeleton is exposed and falls to pieces.

The process of putrefaction is accompanied by the generation of gases very offensive to the smell, such as sulphureted hydrogen, ammonia, nitrogen, carbonic acid, etc.

The time that it takes for a body to decompose depends partly upon the condition of the body itself, but principally on temperature, moisture, and exposure. A moist, high temperature, with free exposure, favors rapid putrefaction. A dry, high temperature has a tendency to dry the tissues and in this way produces mummification instead of putrefaction. Moisture alone tends to produce saponification, especially of the fatty tissues, with the formation of a substance termed adipocere. Putrefaction is less rapid in water and least rapid in earth. Signs of putrefaction begin to appear on about the third day, under ordinary circumstances and an average temperature, commencing with a greenish discoloration in the right inguinal region. Many

months may pass before the soft tissues entirely disintegrate. Judicial examination of the womb has been made nine months after death, where antiseptics had not been used. It is difficult to state how far putrefaction shall have advanced in a given time, for under similar conditions apparently, a very great divergence of results have been observed.

CHAPTER XIV.

THE BLOOD.

Blood, Lymph and Chyle are the nutrient fluids of the body. Others aid in the digestion of food, and still others are only excrementitious. The blood is the most important fluid to the embalmer. It enters largely into the difficulties of his work, causing frequent discolorations. Its property of coagulation often prevents its removal entirely. It is a fluid: when pure, of a bright red or scarlet color (arterial); when impure, of a dull red or purple color (venous).

The blood is composed of plasma, or liquor sanguinis, and red and white corpuscles. The red corpuscles constitute little less than one-half of the mass of blood, are about $\frac{1}{3200}$ of an inch in diameter, and their color is due to the hemoglobin. Leucocytes, or white corpuscles, are much less abundant, existing only in the proportion of one to several hundred of the red corpuscles. The balance of the mass is plasma.

Coagulation of the Blood.—The blood retains its fluidity while it remains in the vessels and the circulation is not interfered with. But after death, or after it is drawn from the vessels, it coagulates or "sets" into a jelly-like mass. It coagulates after death, in the vessels, though less rapidly than when removed from the body.

As a rule it coagulates in from twelve to twenty-four hours after death. The blood is found chiefly in the venous system, the arteries being emptied by post-mortem

contraction of their muscular coats. In the veins coagulation is slow and imperfect. Coagula are found in the left side of the heart and aorta, but they are much smaller than those found in the right side of the heart and large veins. The blood in the capillaries and smaller veins does not coagulate, or, if it does, it coagulates very imperfectly. It gravitates rapidly to the dependent parts of the body.

Coagulation can be retarded or prevented by the addition of certain chemicals, such as the solutions of potash and soda and some of their salts. Other conditions prevent or retard coagulation. The poison of venomous serpents, narcotic poisons, prussic acid, suffocation, whether by drowning, hanging, or poisonous gases, prevent coagulation, while lightning, electricity, blows on the abdomen, cholera or violent exercise retard coagulation in the vessels.

The blood not only causes discolorations, but it decomposes quickly, producing gases, and therefore should be removed. The proportion of the blood to the weight of the entire body is nearly in the ratio of one to eight; or sixteen to eighteen pounds of blood in a body weighing 140 to 150 pounds.

Circulation of the Blood.—If reference is made to the anatomy of the heart, arteries and veins, in the preceding pages, a complete anatomical description will be found. This description should be studied until it is thoroughly understood and committed to memory. The circulation of the blood will then be easily understood.

In the study of the circulation, first remember that all vessels that carry blood away from the heart are arteries, and all those that carry blood to the heart are veins. It matters not whether they carry arterial (pure), or venous (impure), blood, the proposition holds good. The venous blood is carried by the pulmonary arteries, from the right side of the heart to the lungs, where it gives off carbonic

acid gas and receives oxygen, and then, after it is changed into arterial blood, the pulmonary veins carry it back to the left side of the heart. This is called the pulmonary circulation. The heart then forces it out through the aorta and its subdivisions to the capillaries, where it permeates every tissue, gives off oxygen and receives carbonic acid gas, and is carried back through the veins to the right side of the heart. This constitutes the systemic circulation.

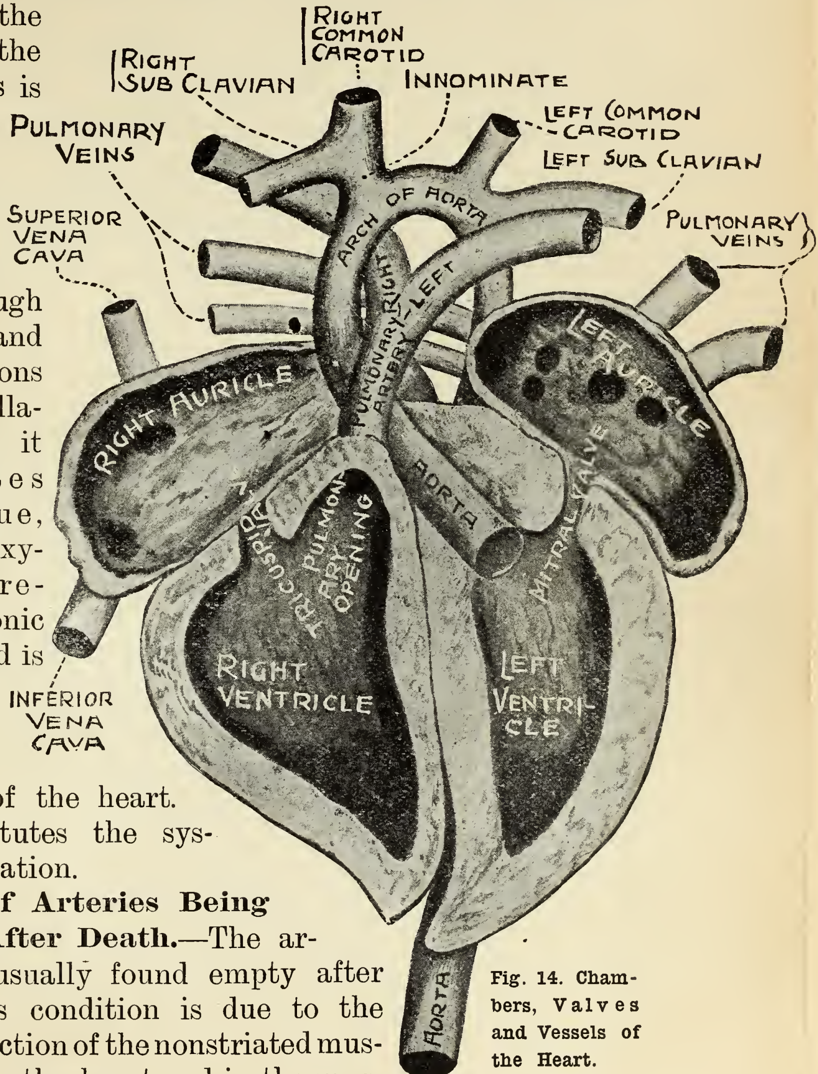

Fig. 14. Chambers, Valves and Vessels of the Heart.

Cause of Arteries Being Emptied After Death.—The arteries are usually found empty after death. This condition is due to the tonic contraction of the nonstriated muscular fiber in the heart and in the muscular coats of the arteries. The muscular walls of the

ventricles and arteries are the first to lose their irritability, become rigid and contracted within an hour or two after death, usually remaining in that state for ten or twelve hours, and sometimes for twenty-four to thirty-six hours, then become flaccid again. The contraction of the arteries is so great as to produce great diminution of the caliber. This no doubt contributes largely to the passage of the blood from the arteries into the veins, which almost invariably takes place within an hour or two after death. It also frequently prevents a free flow of fluid through the arterial system.

CIRCULATION OF FLUID.

The circulation of fluid is not exactly the same as the circulation of the blood. It does not pass through nor into the heart, unless it makes the entire circuit of the systemic and pulmonary circulations, which it is not likely to do, unless a large amount of blood is withdrawn, or one of the needle processes is used. For instance, if the right brachial artery is raised for the purpose of injection, the fluid starts at the point of operation and passes through the axillary and subclavian to the innominate, there taking the downward course (provided the body be on the incline), into and through the aorta to the most dependent parts, filling them first and reaching each arterial branch successively, as the level of the fluid rises, supplying the tissues, reaching the upper extremities, neck and head, last. After this point is reached, enough fluid should be injected to cause it to pass through the capillaries, which will be indicated by the increasing size of the superficial veins, especially those on the forehead.

CHAPTER XV.

EMBALMING INSTRUMENTS: THEIR USE AND CARE.

The development and growth of embalming, especially arterial, has brought into existence a diverse and extended list of instruments and accessories, necessary or useful to the embalmer in the performance of his work. This allows of great latitude in their selection, ranging in price from the cheapest to the most expensive, in adaptability from the most primitive to the most modern, and in grade from the poorest to the best. One's ability as an embalmer may be judged by the quality, condition and appearance of his instruments.

Instruments Should Be Kept Clean.—The importance of keeping embalming instruments perfectly clean cannot be over-estimated, inasmuch as they may be the cause, if not so kept, of serious trouble to those who handle them, either to the operator himself or the assistant. There are many cases on record, some of them of recent date, when serious mishaps have occurred through the careless handling of filthy instruments. Two cases of positive blinding are well known, having come under the immediate knowledge of the authors. One of the victims, a bright young man, son of an undertaker in the South, is at the present time undergoing treatment to the end that his eyesight may be restored. Sore eyes and sore hands

are things of very common occurrence from accidental inoculation from handling dirty instruments.

Aseptic Instruments should be used in all cases. What has been said about the danger from use of dirty and filthy instruments being indisputable facts, every embalmer should become the possessor of a set of instruments which can be easily and thoroughly cleaned. Aseptic is defined as being "free from the living germs of disease, fermentation or putrefaction." Only those instruments are aseptic which are made without visible joint, or which can be taken apart and every portion be cleansed. Such instruments, of course, cost more money than some other kinds; but, the embalmer can make a great point in his business by having his instruments of the very best and most approved style.

Should Take Just Pride in His Instruments.—The up-to-date surgeon prides himself on his fine and perfectly-kept instruments, always adding the very latest and best improvements. So does the dentist and physician. These are professional men with whom the embalmer is, or certainly should be, on a level. They guard and care for the instruments of their respective professions more carefully than anything else they possess. It is a true saying, and one to be cherished, that a workman is known by his tools.

The progressive undertaker spends thousands of dollars for his equipment of funeral cars, hearses, carriages, and horses, and in his show room and its contents. Ofttimes one thing only is neglected. The old, well-worn cabinet, with its rusty set of tools, often filthy and full of septic matter, is still allowed to do service, when in fact this part of his paraphernalia should be the one which he should take pride in having as nearly perfect as possible. When called to take charge of the remains of some prominent citizen, where no expense is spared in all the necessary

furnishings, how inconsistent it is not to be able to conduct the embalming on an equal scale.

Sterilizing Instruments.—To sterilize instruments is to render them free, by heating or otherwise, from living germs. The following formula for sterilizing is simple, cheap and effective:

First thoroughly wash the instruments with soap and water; place in a tin vessel a quart of water, to which has been added a quarter of a pound of bicarbonate of soda; immerse the instruments and boil for half an hour; take out and wipe with a soft, woolen cloth until they are thoroughly dry, when they will be positively free from all danger of inoculation.

To Remove Rust from Steel Instruments.—In case steel instruments should become rusted they can be made perfectly bright by a very simple but effective process. First rub them over with sweet oil; then bury them over night in ordinary white, dry, slacked lime. In the morning remove them from the lime bath, rub them with a soft cloth, and they will become bright and shining.

Instruments Should Be Sharp.—The embalmer's instruments should be sharp and keen cutting, or else the operations cannot be made as quickly or neatly as they should be. A jagged cut is always unsatisfactory, and appears unworkman-like and unprofessional.

The Number and Quality of instruments to be possessed of course must be settled by the individual. As already intimated, the larger the number and variety of instruments and the better their quality, other things being equal, the better will the embalmer be equipped for his work. Any first-class, reliable manufacturer or jobber will furnish an illustrated and descriptive catalogue of instruments and supplies from which a selection can be made of those needed or desired. The selections should

be made with care, especially if the amount available for this purpose is anyways limited.

The Instruments Necessary for Arterial Work are a scalpel, bistoury, scissors, grooved director, forceps, chain and hooks or automatic stretcher, aneurism needle, tenaculum, a good pump (aspirator and injector), an assortment of arterial tubes (different sizes and lengths), thread, needles, absorbent cotton, sheet lint, isinglass plaster, and a number of accessories.

Instruments Used for Cavity Injection.—The operator should select several trocars or hollow needles of different sizes and lengths, from the infant to the adult size, and from six to fifteen inches in length ; a couple sizes of hard rubber nasal tubes; a stomach tube, silk No. 14 or 15; and a good aspirator.

CHAPTER XVI.

ARTERIAL INJECTION.

SELECTION OF THE ARTERY TO BE INJECTED.

In the male subject convenience should govern the operation, unless blood is to be withdrawn. If the latter is necessary, then select either of the femorals, the left brachial, or one of the common carotids. If a female, avoid the femorals, on account of the necessary exposure that will follow in that region of the body. Avoid the common carotids on account of the mutilation leaving an unsightly scar that may interfere with the wishes of friends in regard to the dressing of the body. Either one of the brachials or radials may be raised, unless blood is to be withdrawn through the basilic vein; if such is the case raise the left brachial artery and the left basilic vein, on account of the curve being more gradual in the left vein than in the right. If it becomes necessary to raise the femoral in the female, do so without any hesitancy. Undue exposure can be avoided by placing an old bed sheet over the body, and cutting a slit through it over Scarpa's triangle. The operation should be performed through the slit in the sheet. When bodies are dressed the radial can be used in either sex. One artery is as good as another for the injection of fluid, if no occlusion exists in the artery. The artery can be raised in any part of its course, without reference to the collateral circulation. There is always sufficient collateral

circulation to supply the distal end of the artery with plenty of fluid.

THE RAISING AND INJECTING OF ARTERIES.

To Raise an Artery at any point, the embalmer should be acquainted with the anatomy of the part as well as the linear and anatomical guides for making the incision. He should be able to distinguish between an artery, vein and nerve.

An artery is accompanied in its course by one or more veins and usually by a nerve, and all are encased in a single sheath.

The artery is usually empty, cylindrical in form, of a creamish white appearance, and somewhat firm to the touch.

The vein usually contains venous blood, is of a bluish tint, is flattened, and of a soft velvety feel.

The nerve is white, hard, and dense in structure.

The brachial, femoral, common carotid, radial and posterior tibial arteries are the ones most frequently operated upon for embalming purposes.

In raising an artery an incision should be made in the skin at the proper place, of sufficient length to expose an inch or more of the artery when it is raised out of the wound; less will do for the radial. After making the cut through the skin, dissect carefully down to the sheath of the artery; incise the sheath with the scalpel on the grooved director, or with the scissors, and raise the artery out of the wound. Make an incision through the wall of the artery, either diagonally or transversely. The sharp-pointed, straight or curved bistoury, is a good instrument for incising the artery or vein. After the incision in the artery is made, insert an arterial tube with the nozzle toward the heart. Tie the artery around the tube.

When fluid appears at the distal end of the artery, it can be tied. The appearance of fluid indicates an intact, collateral circulation. If the fluid does not appear at the point of incision by the time the other parts of the body have received enough, remove the tube and tie the proximal end, and insert it into the distal end and fill that part of the body with fluid.

Always inject fluid into an artery very slowly; never be in a hurry, but be patient, and take plenty of time, which is usually necessary to insure the best results. Rapid and careless work may destroy the circulation, or "flush the face."

THE BRACHIAL ARTERY AND BASILIC VEIN.

Location.—The brachial artery may not follow the regular course, but it may descend down towards the inner condyle of the humerus. It may divide and descend as two trunks—each reduced to about half the normal size—in the same sheath and unite again at the lower part of its course; or, they may continue on through the forearm as the radial and ulna arteries.

The Linear Guide.—To mark out the course of the brachial artery, draw a line from the middle of the axillary space (armpit) to the center of the elbow, provided the palm of the hand is supinated (turned up). If not supinated, direct the line to the center of the inner condyle of the humerus.

The Anatomical Guide.—The artery is situated on the inner side of the arm, extending from the lower part of the axillary space to the middle of the elbow joint. Its guide is the inner border of the biceps muscle. It lies in the groove between the biceps and triceps muscles. It is superficial throughout its entire course, being covered only by the skin, superficial and deep fascia.

To Raise the Artery or Vein, and inject artery, bring the arm out from the body to near a right angle and turn the palm of the hand upward. In this position the guide line will indicate the precise course of the artery. Make an incision through the skin, and superficial fascia on the line, two or three inches in length, beginning about three or four inches above the elbow joint; then catch up the deep fascia with the forceps and divide it. This will expose the vessels to view and their relation can be studied. The artery will be seen between the vein and nerve, the basilic vein on the inner side and the nerve on the outer. The artery should be separated from the vein and nerve. If blood is to be withdrawn take up the vein and proceed as directed for opening the basilic vein. Then raise the artery out of the wound, make a diagonal or transverse incision through the wall, and insert the arterial tube with point towards the heart. Tie the artery around the tube; also, the end back of the tube (distal end). Attach the pump and begin the injection of fluid slowly and carefully, as force and rapidity may rupture the capillaries and cause "flushing of the face." Continue the injection until the fluid has passed into or through the capillaries. Always inject enough fluid.

THE FEMORAL ARTERY AND VEIN.

Location.—The femoral artery is situated on the anterior and inner side of the thigh, extending from Poupart's ligament to the upper border of the popliteal space, where it becomes the popliteal artery.

Linear Guide.—To locate the course of the femoral artery, a line should be drawn from the front of the prominence of the ilium (hip bone) to the center of the pubic arch. This line indicates Poupart's ligament. A second line should be drawn from the centre of Poupart's ligament to the inner side of the kneejoint. The latter line will

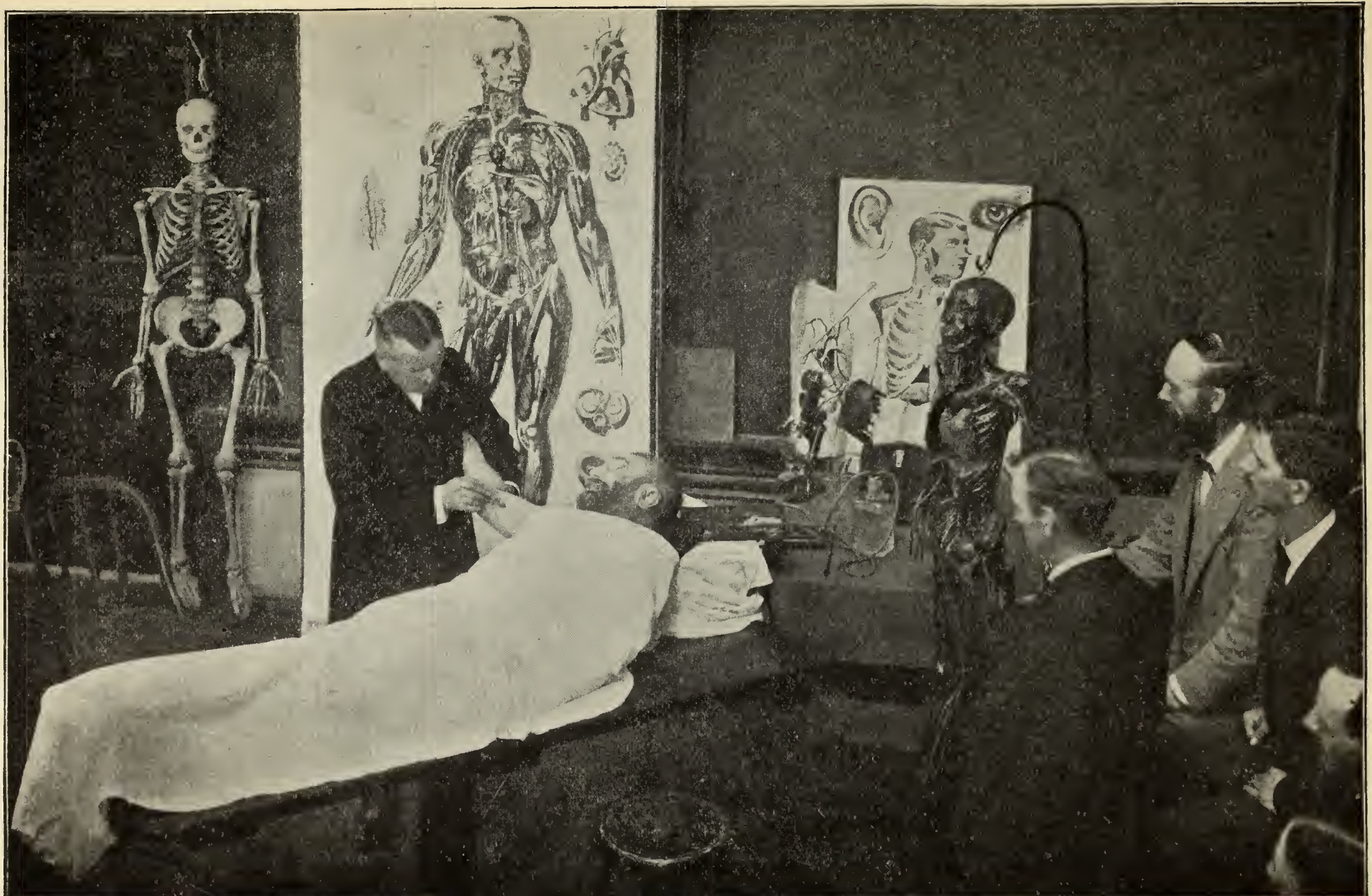

Fig. 15.—RAISING THE BRACHIAL ARTERY.

indicate the course of the femoral artery, when the foot is turned out.

The Anatomical Guide is the inner border of the sartorius muscle, which arises from the front part of the hip bone and passes obliquely downwards and inwards to be inserted into the upper, internal surface of the tibia just below the kneejoint. In the upper part of its course the femoral artery passes through Scarpa's triangle, from its base to its apex. The base of the triangle is bounded by Poupart's ligament, inner side by the adductor longus, and the outer side by the sartorius muscle.

To Raise the Artery or Vein, make an incision from two to three inches in length in the lower part of Scarpa's triangle, or about two inches below Poupart's ligament, through the skin, fat and superficial fascia. Then dissect the deep fascia from the sheath containing the vessels. After this has been done, raise the sheath and place the handle of the bistoury beneath it. The sheath should now be opened and the artery and vein separated. If blood is to be withdrawn from the vein, lift it upon the end of the finger, incise the wall, insert the long silk vein tube and proceed to remove the blood. This accomplished, make a diagonal or transverse incision through the wall of the artery, insert the arterial tube with the point towards the heart and tie the artery around it; then attach the pump and begin the injection slowly and carefully. Inject enough fluid to thoroughly fill the tissues. After sufficient fluid has been injected, the tube may be capped if there is a suspicion that another injection will be necessary. If not, remove the tube, tie the artery and sew up the incision.

THE COMMON CAROTID ARTERY AND INTERNAL JUGULAR VEIN.

The Common Carotid Artery has no particular advantage over any other except in size. It is the largest

artery used for embalming purposes. It is situated in the neck, and extends from the upper border of the larynx (Adam's apple) to the sterno-clavicular articulation. It is scarcely possible to raise it without leaving an unsightly scar, unless you incise the skin on the clavicle and draw it upward. Therefore it should not be used unless unavoidable.

The Linear Guide to the location of this artery is a line drawn from behind the ear, downward to the joint of the sternum and clavicle. This will indicate the position of the artery.

The Anatomical Guide is the anterior border of the sterno-cleido-mastoid muscle, which arises from the upper end of the sternum and inner end of the clavicle, or collar bone, crossing upward and a little backward to be inserted into the mastoid process of the temporal bone.

To Raise the Artery and Vein the operator should begin the incision about an inch above the sternum in the line that indicates the course of the artery and continue it upward about one inch. Then dissect down carefully to the sheath which contains the artery, vein and pneumogastric nerve. Open the sheath and separate the artery from the vein and nerve. Raise the vein, insert a drainage tube and let the blood drain from the head and face. Then raise and incise the artery, insert the arterial tube with the point towards the heart, tie the artery around the tube and tie it back of the tube. Commence the injection slowly and carefully. Inject sufficient fluid to fill the tissues of the body. Remove the tube, tie the artery and carefully close the incision.

THE RADIAL ARTERY.

To Locate and Raise the Radial Artery is very simple. It can be raised in a moment and it will receive the fluid as fast as it should be injected in any case. Its position makes it very convenient for that purpose when the body

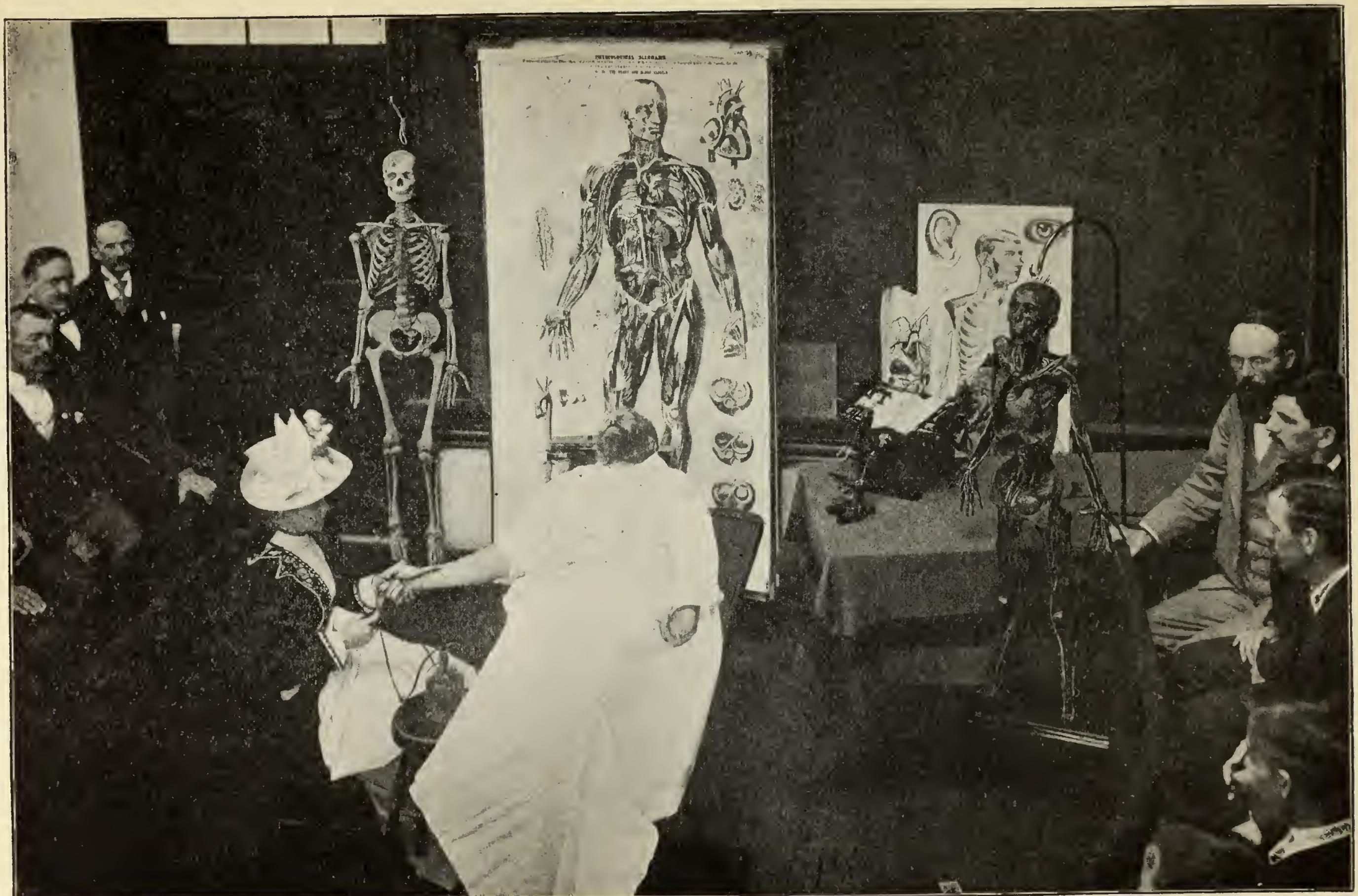

Fig. 16.—INJECTING THE ARTERIAL SYSTEM THROUGH THE RADIAL ARTERY.

is already dressed for burial. At the point where it is usually raised, it lies very superficial, being covered only with the skin and superficial fascia. To raise the artery, make an incision along the groove on the radial side of the wrist where the physician takes the pulse rate, about an inch or less in length, through the skin and superficial fascia. This artery can also be raised higher up along its course, where it will be found somewhat deeper. Open the sheath, raise the artery, incise it and insert the small arterial tube with the point toward the heart; tie the artery around and behind the tube. The wrist should be tied tightly behind the tube to prevent a great amount of fluid from reaching the hand, which is not desirable. Attach the pump and inject the fluid slowly and carefully. After sufficient fluid has been injected, remove the tube, tie both ends of the artery, sew up the incision and cover with isinglass plaster.

THE POSTERIOR TIBIAL ARTERY.

Location.—The posterior tibial artery is found on the posterior surface of the leg, extending from the lower border of the popliteal space downward behind the inner malleolus (ankle), where it becomes the plantar artery.

To Raise the Posterior Tibial Artery an incision should be made beginning at the upper border in the depression, and extending in a curved line around the internal malleolus or ankle. Dissect down to, and open, the sheath, raise the artery, make an incision in the artery and insert the arterial tube with the nozzle toward the heart. Tie the artery around the tube, attach the tube and inject fluid sufficient to fill the tissues of the body. Then remove the tube, sew up the wound and cover with plaster. After the injection place the trunk and lower extremities on a level, with the head slightly elevated. This will prevent the fluid from gravitating to the lower organs and extremities.

TO REMOVE THE BLOOD.

The Blood should be removed from the veins to relieve the tissues from the pressure; to make more room for the fluid to pass through the capillaries and smaller vessels; to relieve the congestion of the superficial or peripheral veins of the head, face and neck, thereby removing discoloration from that source; and to relieve the tissues from the changed and putrid blood, which decreases the chance of preservation, and gives rise to "post-mortem discoloration" and "post-mortem staining."

The Methods of removing blood from the body are by aspirating the heart or veins, or by drainage.

To Remove Blood from the Heart, a trocar, or hollow needle, and an aspirator, are required. Select a needle or trocar six inches or more in length, very sharp and of fair caliber. The arrow-pointed needle is an excellent instrument for the purpose. Introduce the needle between the third and fourth ribs (third intercostal space) on the right side, within half an inch of the right border of the sternum (breastbone), directing it downward and a little to the left, to the depth of about four inches, or until the point of the needle touches the spinal column, when it will have entered the right auricle of the heart. After the needle has been introduced, attach the aspirator, place the body in a sitting posture, and raise the arms above the head for the purpose of gravitating the blood toward the heart. To remove the blood from the lower extremities the position of the body must be reversed, as blood can only be removed from the body by the aid of gravitation, or while the mouth of the tube, or the point of the needle, is immersed in the fluid. The vacuum in the heart is not filled by the pressure of air, as in the common pump, but by the force of gravity.

Circulation Not Destroyed by Tapping the Heart.—Objection has been made to this operation by some

Fig. 17.—ASPIRATING BLOOD FROM THE HEART.

embalmers raising the point that the circulation is destroyed for arterial embalming. The point is not well taken. The right auricle being the only part wounded, the fluid would have to make the whole circuit of the circulatory system before it could escape. However, the heart may be occupying an abnormal position, as a result of effusion into one of the pleural sacs or some other disease ; such being the case, the left side of the heart or aorta may be injured. Even injury to the left auricle or ventricle would not destroy the circulation sufficiently to interfere with arterial embalming, unless the aortic valves were destroyed.

The Valves of the Heart and Veins act just the same after death as they do before. Before death they prevent the backward flow of the blood and after death they prevent the flow of fluid through the heart. Therefore fluid does not enter the left cavities of the heart at all, nor does it enter the right cavities unless it makes the entire circuit of the circulation. The coronary arteries supply the substance of the heart with fluid.

To Remove Blood by the Veins will require at least two silk vein tubes, of different sizes and lengths — of sufficient caliber to enter the vein and long enough to reach the heart —, an aspirator, and the usual instruments for raising an artery. In this operation it is better to select the most convenient vein. The one that accompanies the artery that is chosen for the injection of fluid will be the most convenient, as it is not necessary to make more than one incision for the raising of both artery and vein.

If the Basilic Vein is selected, use the left one, as the left vein has a more regular curve than the right and the tube will pass into the heart without difficulty.

To Open the Basilic Vein.—Tie the vein on either side of the point of incision to prevent the blood from

flowing, until the tube is inserted. Then raise the vein upon the end of the finger, make an incision through the wall, introduce the silken tube towards the heart as far as the ligature; remove the ligature, then pass the tube carefully towards the heart until it reaches the right auricle, and attach the aspirator. On removal of the tube, again tie the vein to prevent leakage.

If the Femoral Vein is selected, either the right or left may be used, as the tube will pass through one about as easily as the other. It will require a larger and much longer tube for the femoral vein, as the point of entrance is at a greater distance from the heart than that of the basilic. More blood can be withdrawn from the femoral vein than any other, as it is more dependent and thus favored by gravity.

The Internal Jugular Vein may be used in the same way. Also, a large, open-end, drainage tube may be introduced upward, and the blood will drain out of the head, neck and face.

The basilic vein tube used should be at least eighteen inches long and No. 8 to 12 in caliber. The femoral vein tube should be thirty inches or more long and No. 8 to 12 in caliber. They should be well oiled before introduction.

If the blood is coagulated, or does not flow freely, inject through the tube a weak solution of the carbonate or sulphate of soda, or common salt (chlorid of sodium), using a ten or twelve per cent. solution. It will likely dissolve the clot, and the blood will flow more readily.

The operations, as described under the directions for raising the different arteries, will apply to the veins.

The Proper Time to Withdraw the Blood.—To obtain the most satisfactory results, the operation of withdrawing the blood should be going on at the same time that the fluid is being injected into the arteries. The

quantity is increased, the flow is easier, and time is saved as well. The greater the quantity of blood extracted from the body the better will be the results.

SECOND INJECTION.

If the case is one that will likely require a second injection the tube should be capped and left to remain in the artery until the time has elapsed for the injection, when the cap can be removed and the injector attached. The interval between the different injections should be at least twelve hours. Sometimes as much fluid can be injected at the second, as at the first, operation. The arteries will be found empty, the fluid having passed into the surrounding tissues by absorption and contraction of the arterial walls, driving the fluid through the capillaries into the tissues and veins. In the course of a day or two the tissues become hard to the touch, that soft natural feeling of the surface will have disappeared, the body will be rigid, the jaws firmly set—an indication that it will keep, as long as it is retained in a dry vault or room.

"SKIN-SLIP:" ITS CAUSES AND PREVENTION.

Slipping of the Skin is a result of the softening of the rete mucosum—the soft layer that contains the pigment or coloring matter of the skin. Many of the profession have been led to believe that the trouble is caused by certain fluids used for injecting the vascular system. This is an error and one that requires correction. Skin-slip is caused by the putrefactive softening of the rete mucosum. This early softening is almost exclusively in cases of heart, liver and kidney diseases, and other morbid changes that result in dropsy, and there is always more or less dropsical effusion into the subcutaneous tissues, which transudes into the rete, causing the putrefactive softening. The general effusion into the subcutaneous and other tissues prevents perfect

capillary circulation of the fluid and thereby prevents the distribution of fluid to the surface. Slipping of the skin frequently occurs when fluid is used only in the cavities, none being injected into the arteries. Under such circumstances how could fluid produce "skin-slip?" No fluid that contains strong antiseptics injected into the vascular system will cause slipping of the skin.

To Prevent Slipping of the Skin, cases that die from diseases that cause dropsical effusion into the subcutaneous (fat) tissues should be carefully handled. The skin on the face and hands should not be rubbed or pressed upon for a day or two, when the effusion will have settled to the dependent parts of the body and fluid will have reached the skin to harden the rete mucosum and dry the surface.

FORMULA AND TREATMENT.

Apply to the face and hands the following:

ALUM, POWDERED, 4 ounces. PURE (grain) ALCOHOL, 1 pint.

MIX; apply by saturating a cloth (several thicknesses) and laying gently over the parts, keeping it moist with the mixture, and allowing it to remain for ten to twelve hours

DISCOLORATION.

Discolorations take place in all bodies sooner or later after death, due to certain changes. The areas of surface that most concern the embalmer, are those that are exposed to view. They may be involved to a greater or less extent. Hypostasis, or congestion of the head, neck and face, may result from the body being left to lie with the head as the most dependent part for some time, the blood gravitating towards the head, causing a red or bluish-red color of the whole surface. The same condition of the surface will result from the forming of gases, in the thoracic and abdominal cavities, in such quantities as to cause pressure sufficient to force the blood out of the large vessels into the

head and face. These discolorations result from over distension of the superficial veins and capillaries with venous blood.

TREATMENT.

In the former case reverse the position of the body ; in the latter, remove the gases. After this, follow with the same treatment in both conditions. Place the body on the incline and withdraw the blood, either through the veins or by tapping the heart. If the blood has become coagulated, make cold applications in the form of pounded ice mixed with salt, applied between two thicknesses of cloth, and exclude the air by covering. If this method of procedure is not successful, use the Champion Needle Process by injecting a few ounces of a ten per cent. solution of sulphate of soda through the cerebral cavity, followed in a little while by a first-class preservative fluid. This will dissolve the clot and wash the blood out of the peripheral vessels.

Hypostasis in other parts of the body does not concern the embalmer, as it exists in areas that are not exposed.

The discoloration caused by post-mortem staining does not require any special treatment.

Congestion of the Peripheral Veins, caused by the hasty injection of fluid, is known as "flushing the face." To remove it resort to the needle process.

The Brownish or Greenish Spots seen occasionally under the eyes, along the nose, and at the corners of the mouth, are usually caused by putrefactive changes in the blood and capillaries. The latter spots may be removed by injecting hypodermically a bleaching solution, using just enough fluid to reach the circumference of the discoloration.

Bruised and Other Spots, as a result of blood exudation, may be removed by the application of finely-pounded ice and salt. Mix the ice and salt together and apply it to

the part as a poultice is applied. Let it remain from one to several hours, or until the discoloration is removed. Sponge with some fluid with good bleaching qualities, or a bleaching solution; allow the surface to dry, and cover with a dry cloth to exclude the air.

Discoloration Caused by Biliverdin (the coloring matter of the bile).—This discoloration takes place during life. It is caused by the blood absorbing the biliverdin—when the flow of bile is seriously obstructed—and carrying it to the tissues of the body. It stains the skin and conjunctiva a yellow or brownish color. A similar discoloration may result from chemical changes in the pigment or tissues of the skin itself. These stainings cannot be removed. Light and shade must be relied on to modify the appearance. The color is permanent and unbleachable.

Bleachers and fluids used on the face serve a purpose in many cases of discoloration. They sometimes aid in bleaching, and also in destroying odors.

THE ICE MIXTURE.

Formula for removing discoloration caused by the blood, by the application of ice: Mix thoroughly three parts of finely powdered ice with one of common salt. Place the mixture between two thicknesses of cloth and apply to the affected parts. Then cover with a blanket or thick towels to exclude the air. The application can be removed in about two hours, when the discoloration will be found to have disappeared. Sponge the surface with a good bleacher and cover with a dry cloth.

A Substitute.—When ice is not available apply the following: Take equal parts of chlorid of sodium (common salt), nitrate of potash (salt petre), and chlorid of ammonia; place in a soft rubber bag; apply to the parts effected, with a thin cotton cloth intervening.

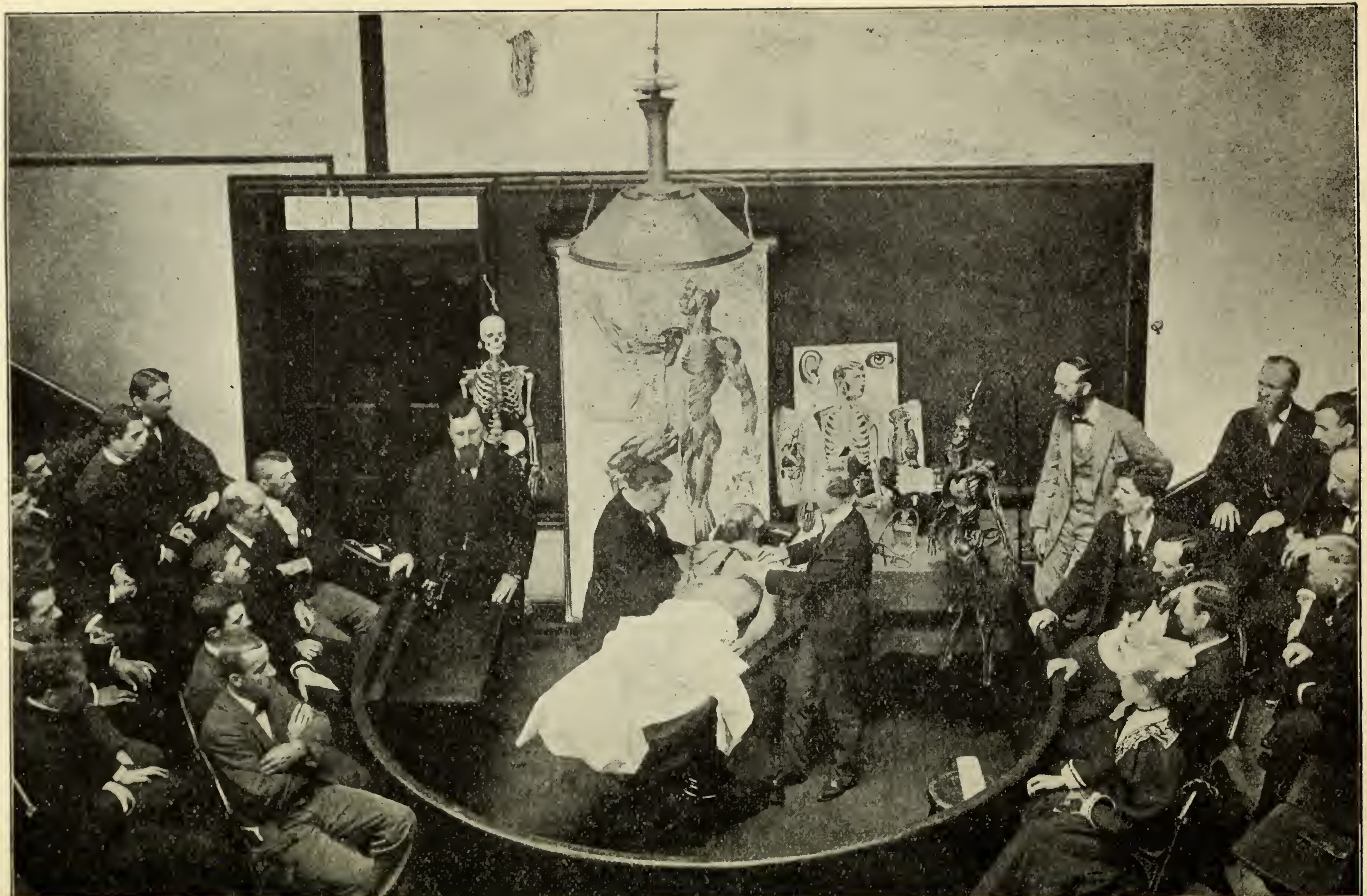

Fig. 18.—MAKING A DISSECTION.

CHAPTER XVII.

CAVITY INJECTION.

The reliance on cavity injection has been decreasing for the last few years. As an auxiliary to arterial embalming it is indispensable. It has been said many times that "cavity work is sufficient to keep the body for the usual time — three or four days." The proposition is true in a great majority of cases. Suppose it would hold good in nineteen out of twenty cases. Is not the fact that one case in twenty fails, reason enough for it to lose favor? That one in twenty, to be kept in the best possible condition, would have to receive a thorough embalmment. Otherwise a failure, or what is known as "a partial failure," would result. Putrefaction does not usually make its appearance, with an average temperature, until the third day. The time would be shortened by a high, moist temperature, and lengthened by a lower, dry temperature. The home of the putrefactive bacteria is in the alimentary canal of the body; therefore, to fill the stomach and intestines and other cavities in the soft viscera with fluid will extend the time of the beginning of disintegration, and possibly long enough for burial on the third or fourth day, or longer, without the evidences of putrefaction manifesting themselves. Even if the body can be preserved for "the usual length of time" by cavity injection alone, as a sanitary measure it would be a sad failure. It would destroy only a part of the bacteria of infection in the body; only

those with which it would come in contact. To destroy all, a thorough arterial injection must be made in addition to the cavity injection.

THE THORACIC CAVITY.

The student should study the anatomy of the thorax until he becomes familiar with the divisions of the chest or thoracic cavity. The chest is bounded below by the diaphragm, above by the root of the neck, in front by the sternum, at the sides by the ribs and behind by the vertebral column. It is divided by the heart and mediastinum into the right and left cavities of the chest, or pleural cavities, containing the right and left lungs, and the space between the lungs—the mediastinal space—containing the heart, aorta, venæ cavæ, trachea, gullet and other vessels.

The Pleuræ are shut, serous sacs. One forms a covering for the right and the other for the left lung. One side of the sac envelops the whole lung clear to the root and is then reflected onto the chest wall so that the other side of the sac lines the wall of the chest, forming what is known as the pleural cavities—right and left.

TO INJECT THE PLEURAL CAVITIES.

Introduce the trocar (the infant trocar is large enough) through the wall of the chest in the first or second intercostal space at a point about four inches from the border of the breastbone. After the point has passed the wall, tilt the needle and push it to a depth of three or four inches, keeping the point near the outer wall of the chest. Then apply the pump and commence the injection. After sufficient fluid has been injected, remove the needle and treat the other side in like manner. From one to four pints may be injected in this way. If the infant trocar is used, the mutilation will amount to almost nothing.

Fig. 19.—DISSECTING THE THORACIC AND ABDOMINAL CAVITIES.

The Pleural Cavities May be Injected from the opening made in the third intercostal space for the purpose of drawing blood from the heart. The needle may be introduced also at the median line. immediately above the breastbone. The skin should be drawn up before the puncture is made. Introduce the needle at an angle of 45° from the median line, alternately into the right and left pleural cavities, keeping the point close to the collar bone. Never introduce the needle any deeper into the cavity than the lower margin of the collar bone. The amount of fluid to be injected depends upon the disease and the judgment of the operator.

To Inject the Lung Tissue, make an incision with the scalpel in the median line just above the breastbone into the trachea between the rings of cartilage; introduce an aneurism hook into the opening; pull the rings apart; then introduce the common hard rubber nasal tube, and pass it downwards into the bronchi (branches of the trachea) on either side, injecting into each lung as much as it will hold. In all cases of consumption or lung fever this method should be used to disinfect and preserve the lung tissues. The lungs can be filled in this manner without endangering the arterial circulation, when it is impossible to insert the nasal tube through the glottis into the windpipe.

TO INJECT THE ABDOMINAL CAVITY.

Insert the needle at the same point as directed in the removal of gases, and inject fluid around the organs and into every part of the cavity, being careful not to injure the blood vessels. From one to four quarts of fluid should be injected, owing to the disease and size of the body. After the removal of the needle the wound should be stitched and covered with isinglass plaster.

To Inject the Stomach and Intestines.—The most successful method of filling the stomach and intestines is

by introducing a stomach tube into the stomach through the nostrils or mouth.

TO REMOVE GASES AND LIQUIDS.

To Remove Gases from the Thoracic Cavity.— Gases may accumulate in the pleural cavities, which can be removed by the needle, by inserting it as directed in the description for injecting the pleural cavities. P. 156.

To Remove Gases from the Abdominal Cavity.— Regional anatomy should be studied very thoroughly, until the student becomes familiar with the regions, location of the blood vessels, all organs and other viscera of the abdomen. As a result of the early putrefactive changes that take place in the soft viscera of the abdomen, putrefactive gases are formed — such as sulphureted hydrogen, ammonia, nitrogen, carbonic acid, etc. — causing very offensive odors. To remove the gases, insert the needle at a point one inch below the ensiform cartilage, or point of the breastbone, and one and a half inches to the left of the median line, to avoid injuring the blood vessels. The needle should be made as sharp as a point can be made, as the organs cannot be punctured with a dull needle, when they are distended with gas to their full capacity. First puncture the stomach, then the intestines, being careful not to wound the blood vessels. If the needle is sharp, and the organs are properly located, a failure to remove the gas in this manner, if persisted in, will be impossible. Let the gas pass into the fluid bottle through the rubber tube.

To Remove Liquids from the Abdominal Cavity, insert a large, sharp needle at the median line just above the pubic arch. Push it into the parts which contain the matter. Place the body on the incline, attach the aspirator and pump out the liquid.

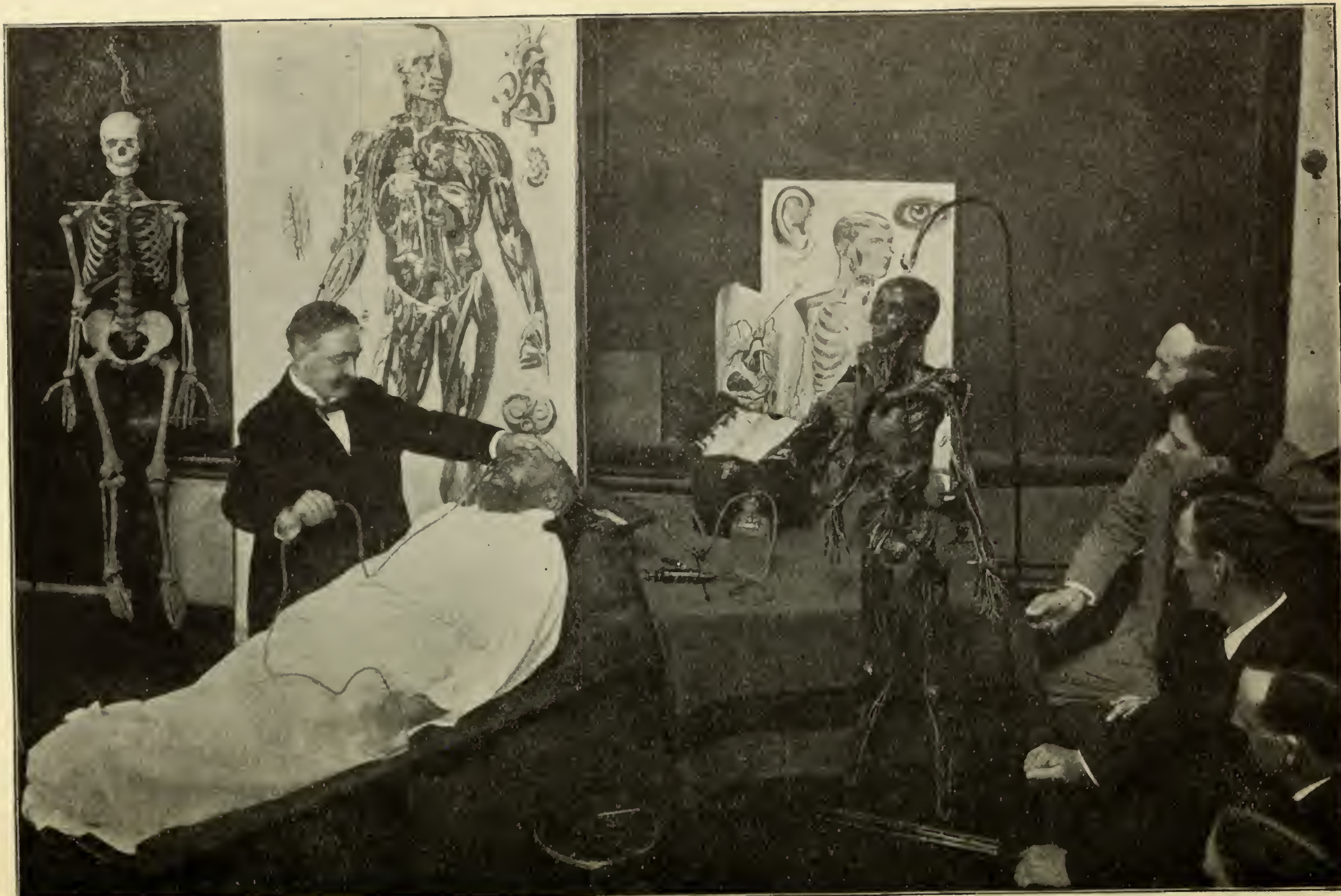

Fig. 20.—ARTERIAL INJECTION BY THE EYE PROCESS.

CHAPTER XVIII.

THE NEEDLE PROCESSES.

THE EYE PROCESS.

The needle process was introduced by Prof. F. A. Sullivan, in the fall of 1891, to the profession in this country. The method consisted of introducing two small needles into the inner corner of each eye, through one of the foramina at the inner end or point of the sockets to the base of the brain, and injecting fluid. This is known as the "Eye Process."

The Operation. — The body should be placed on the embalming board in an elevated position. A small needle about six inches in length (known as the eye trocar) should be introduced at the inner corner of each eye, directing its course along the inner wall of the orbit, through the small foramen at the point of the socket, into the cranial cavity, to a distance of about four or five inches; then tilt the head backwards and raise the body to nearly a sitting posture. The injector should be attached to the needles and the injection should be begun very slowly and without force. After a few moments the rapidity can be slightly increased. From two to four pints can be injected in this manner in from twenty to thirty minutes. The only objection to this method is, that an accident may occur if too much force is used at the beginning of the operation, or, if the needle is

withdrawn too soon, fluid may regurgitate and fill the loose tissues behind and push the eye forward. If this result should obtain, it is no serious matter, as the fluid will disappear after a short period of time by absorption and gravitation and allow the eye to settle back in its place. To prevent such a result, be careful to inject slowly and use the least force at the beginning of the injection, and after the injection is finished allow the needle to remain in position for a period of five to ten minutes before removal. Do not lower the body until after the needle is removed. This method is as scientific as any method ever introduced for embalming through the cerebro-spinal cavity.

TO INJECT THROUGH THE FORAMEN MAGNUM.

The introduction of the needle through the foramen magnum into the cerebral cavity has been recommended. The manner of distribution of the fluid is just the same as that in the eye or Champion processes. The only difference is the point of introduction of the needle. To introduce the needle through the foramen magnum, it is necessary to incline the head to one side and bend it downward upon the chest. If rigor mortis is present break it up before the attempt to introduce the needle is made. Then draw a line from the lower angle of the jaw straight around the neck. Then a second line from the mastoid process to the center of the clavicle or collar bone. The lines will cross just back of, and a little below, the lobe of the ear. Introduce the needle on the first line at a point one inch behind the crossing of the lines, directing the needle upward and inward toward the opposite eyebrow, when the needle will enter the cavity with ease. Then apply the injecting apparatus. This operation has not met with much favor.

Fig. 21.—INJECTING THE ARTERIAL SYSTEM BY THE CHAMPION NEEDLE PROCESS.

THE CHAMPION NEEDLE PROCESS.

This process for injecting fluid through the cranial cavity into the circulation is attended with the least danger.

The Operation.—Place the body on the embalming board. Drill a small hole through the skull in the slight depression immediately in front of the occipital protuberance in the median line. Introduce a small needle, about four or six inches in length, to a depth of about two and a half to four inches, between the lateral halves of the brain. The needle may be inclined backward or forward but not to either side. It will pass through the superior and inferior longitudinal sinuses, then into the ventricles and subarachnoidean spaces.

After the needle is properly introduced, place the body in nearly a sitting posture for the purpose of taking advantage of the force of gravity. Then attach the injector and commence the injection very slowly, using the least force; after a few moments the flow can be increased, so that from three to four pints of fluid can be injected into the body in from twenty to thirty minutes. It may be necessary to push the needle a little deeper or to withdraw it partly to start the flow. In this operation the fluid gets into the vascular system by exudation. The drill should be large enough to admit the needle easily; it does not matter if it is even a size larger, so as to give easy entrance. Do not let the drill drop through the membranes, after the bone is penetrated, or the fluid, if a little too much force is used, will appear at the opening; otherwise, not a drop of fluid will escape. The fluid reaches the ventricles and subarachnoidean spaces and is distributed to the whole surface of the pia mater, the vascular membrane of the brain; the arachnoid, the serous membrane; and the dura mater, the fibrous membrane. The fluid exudes through the walls of the smallest arteries and veins, and the capillaries of these

membranes, and through the walls of the sinuses, and, assisted by the force of gravitation, is carried to every tissue of the body.

This operation is not recommended to take the place of arterial embalming in all cases, but, when the needle process becomes necessary, we do recommend it as the simplest, best, and the easiest to practice.

In infants and small children the arteries are usually too small for the use of distributing fluid into all the tissue by the usual method of injecting through the arteries. Also, in certain diseases, the arteries are found to be occluded. In all such cases the Champion Needle Process will be found successful, and should be used.

A small rachet drill is made for the purpose of drilling through the skull, by the use of which the operation can be effected in a few seconds.

PART THIRD.

MORBID ANATOMY AND TREATMENT OF SPECIAL DISEASES.

INTRODUCTORY REMARKS.

The morbid changes which take place in the different organs and tissues of the body, as a result of the many diseases that human flesh is heir to, are scarcely understood by the embalmer. In many cases his knowledge of the real condition of the visceral organs and tissues is very slight indeed. There is nothing more essential, in the practice of embalming, than to understand which organs are affected and what their condition is at death. It will be our endeavor to place before our readers, in as plain terms as possible, the morbid anatomy of certain diseases, and their treatment. We shall be limited to only the most important diseases.

Definition.—Morbid Anatomy treats of the changes produced by disease in the solids and fluids of the body, as in the blood, muscles, skin, secretions, etc. The different cavities contain effusions of blood serum, purulent matter, etc. We will show which organs and tissues are affected by complication and otherwise, so that the embalmer may know where to look for, and how to reach, all diseased tissues, for the purpose of destroying the bacteria of infection and putrefaction, and to preserve the parts thoroughly, and thereby have no "failures."

CHAPTER XIX.

ACUTE INFECTIOUS DISEASES.

SMALLPOX.

Smallpox is an acute infectious disease, very contagious, produced by a specific micro-organism.

Morbid Anatomy.—The morbid changes are observed on the skin and mucous surfaces. Embalming for preservation should not be considered at present at all, but the body should be thoroughly embalmed as a sanitary measure.

TREATMENT.

It is a great mistake not to inject these cases. While it is true that they are not exposed to view as other cases, and are hurriedly buried, nevertheless, as a protective measure, such bodies should be scientifically treated, thus assisting the sanitary authorities in preventing the spread of this loathsome disease. It is a well authenticated fact that years after interment the ground when opened gave forth the germs that caused an epidemic. Some reader may be placed in a position outside of large cities, where the authorities have not provided trained men to handle these bodies, leaving the disagreeable and dangerous task to the undertaker. If bodies dying from smallpox were treated as follows, it might be the means of saving many lives:

Wrap the body in a sheet thoroughly saturated with a solution of bichlorid of mercury, one ounce to a gallon of water. Inject the cavities through the sheet with all the embalming fluid it is possible to put in them. Mix twenty-five pounds of hardening compound with same amount of sawdust. Place a layer in bottom of coffin. Place body on top of it and cover with the remainder of the mixture.

When the body is placed in a sheet saturated as directed, there is no immediate danger to the operator from the body — not any more than there would be in handling it as it is ordinarily done. The time is coming when all cases dying from contagious diseases, including smallpox, will be arterially embalmed, in addition to some such treatment as that just given. Epidemics will then be less frequent.

SCARLATINA — SCARLET FEVER.

Scarlatina is an infectious and contagious febrile disease. A scarlet flush generally appears on the fauces and pharynx, and in the face and neck, which spreads over the whole body and commonly terminates in scaling. The fever is accompanied with affection of the kidneys, often with severe disease of the throat or of some internal organ, sometimes followed by dropsy. As in other fevers the poison of scarlet fever acts on the brain and its membranes, causing inflammation.

TREATMENT.

These bodies, as in other contagious diseases, are buried soon after death; consequently, the aim of the embalmer is to disinfect rather than preserve. Nevertheless, they should be thoroughly embalmed to make disinfection

more effective. First wrap the body in a sheet thoroughly saturated with a solution of bichlorid of mercury, one ounce to a gallon of water. Inject arteries and cavities with embalming fluid. The saturated sheet should be left on the body until it is about to be placed in the coffin or casket. The room should be fumigated and disinfected as directed elsewhere.

DIPHTHERIA.

Diphtheria is an acute infectious disease, caused by an infectious bacillus. It is highly contagious and in the malignant form is a very grave disease, with a high mortality rate. It is principally a disease of childhood, although no age is entirely exempt. Occasionally an adult becomes infected.

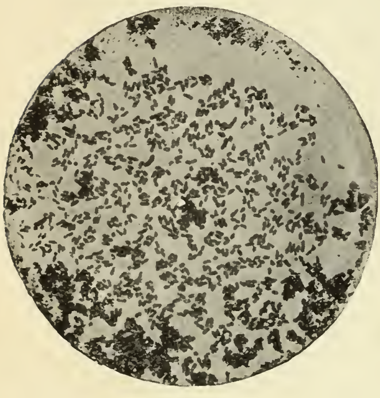

Fig. 22.
Bacillus Diphtheriæ, from colony upon an agar plate, 24 hours old, X 1000. From a photomicrograph by Fränkel and Pfeiffer.

Morbid Anatomy.—It is characterized by a false membrane in the throat, nose, and other parts of the mucous surfaces. The fauces are usually the only parts found covered with the false membrane. Although a constitutional disease, the morbid changes are not apparently very great.

TREATMENT.

The treatment should be similar to that of scarlatina or scarlet fever. The embalmer should be careful not to wound himself with any of the instruments used in embalming the case. The great tendency is to blood poisoning when wounds occur during the dissection of all infectious diseases. Fill the mouth and nostrils with fluid in addition to the treatment given for scarlet fever.

TYPHOID FEVER.

Typhoid fever is an acute infectious disease, due to the presence of a micro-organism—the typhoid bacillus.

Morbid Anatomy.—When death occurs early in the disease, the body is not greatly emaciated; rigor mortis is marked; there is hypostatic congestion in the dependent parts. The muscles appear very dark red, hard and dry, when cut through in opening the body. The blood in the heart and large vessels is thick, dark in color, and contains small, blackish-red coagula. This dark color indicates an increase of blood corpuscles, and results from the thickening of the blood, caused by perspiration and loss of water by diarrhea.

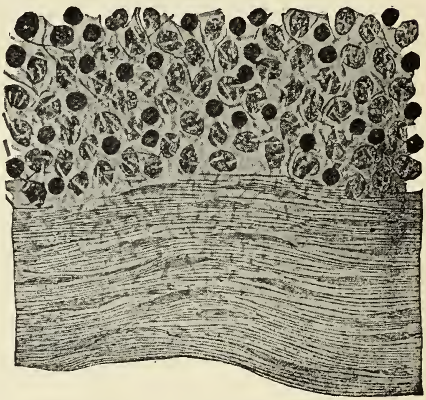

Fig. 23.

Section through wall of intestine showing invasion by typhoid bacilli, X 950 (Baumgarten).

If this were the condition in which all bodies dying from typhoid fever were found, there would likely be no trouble, unless it were in withdrawing the blood.

If death occurs later in the disease, the body is more or less emaciated; the skin is pale; rigor mortis moderate; there is less hypostatic conjestion; bed sores are usually present; the muscles are pale and infiltrated.

The blood is now fluid in the heart and large vessels, and often contains fibrinous clots, and is easily withdrawn. The organs of respiration are changed more or less in all cases. Occasionally there is ulceration of the throat and trachea; congestion of the bronchi; more or less hypostatic congestion of the lungs and sometimes splenization.

Pneumonia frequently occurs and may be complicated with pleurisy. The spleen is sometimes more or less enlarged and softened; it may be from twice to six times its normal size; rupture of the capsule may have occurred, followed by the escape of blood into the peritoneal cavity.

The most important changes take place in the small intestine. The typhoid bacilli seem to attack the solitary and Peyer's glands in the lower part of the ileum. Owing to the time that death occurs, whether early or late in the disease, we may find these glands enlarged from the size of a pea to the size of a silver dollar, and in the vicinity of the ileo-cæcal valve they may coalesce and cover a strip of the wall of the intestine several inches in length. The mesenteric glands are enlarged from the size of a hazelnut to the size of a hen's egg.

Late in the disease, Peyer's and the solitary glands may slough, leaving an open ulcer. At this time the contents of the bowels are of a pea-soup-like appearance and consistency, and the large intestine is inflated with gas.

Perforation of the intestine may have taken place, through which gas and fecal matter will have passed into the peritoneal cavity, causing peritonitis. Sometimes other organs are involved—the bladder, the kidneys, the liver, the meninges of the brain. In some cases the muscular tissues become soft and easily broken down.

TREATMENT.

If gas is present remove it from the body. The blood should then be withdrawn by tapping the heart or a vein. If death occurs early in the disease, and the blood should be clotted in the heart, inject and eject a ten per cent. solution of common salt, until the clot is dissolved. If the peripheral veins of the neck and face should be congested, apply the ice poultice, or cold mixture, or use the Champion Needle Process, and inject two or three quarts of fluid.

When death occurs later, the blood is fluid. After withdrawing all the blood that is possible, or at the same time, commence the injection of fluid into the artery, gently and carefully, and continue until the body has received a sufficient amount to thoroughly fill the tissues. Next, treat the cavities, being careful not to injure the blood vessels. Remove the contents of the pleural cavities by aspiration, and fill them with fluid. This should be done by introducing the long trocar in the third intercostal space, at the same point used for tapping the heart; then, inject the lung tissues through the trachea; the stomach should be filled through the stomach tube, or, by the needle, introduced into the stomach through the abdominal wall. The intestinal canal should be filled with fluid, as it is the reservoir of a putrid mass, containing millions of putrefactive, infectious bacteria. The peritoneum should be thoroughly injected. Each organ should be surrounded, and the whole abdominal cavity should be injected with all the fluid that it will hold. Then place the body on the level, with the head only elevated, so that the fluid will not gravitate away from the viscera in the upper part of the cavities. After a few hours pump out the fluid from the cavities and refill. Treat every case of typhoid fever very thoroughly, as many of them are difficult cases to preserve, and no living man can select those that are easy.

TYPHUS FEVER.

Known Also as Ship Fever.

This disease is known by the latter name, from the fact that it is imported in vessels bringing emigrants from Ireland to this country. Typhus is an acute infectious disease, highly contagious. The percentage of mortality is about the same as that of typhoid fever.

Morbid Appearances.—Emaciation is not well marked unless the case is protracted through the intercurrence of complications when it may reach an extreme degree. Rigor mortis is not well marked and usually lasts but a short time. Hypostasis occurs rapidly, and putrefaction begins very soon after death. The only constant lesion noticed in this disease is the profoundly changed condition of the blood, which is dark in color and very fluid. If clots exist at all they are large and soft and easily broken down. The amount of fibrin and the number of red corpuscles are diminished, but the number of white corpuscles are increased. No doubt a specific poison of some kind exists in the blood. Therefore, in the

Fig. 24.

Bacillus Typhi Abdominals, from single gelitin colony, X 1000. From a photomicrograph by Sternberg.

TREATMENT

of this disease, as much of the blood should be removed as possible. To do this raise the femoral artery and vein and proceed in the same manner as directed in the treatment of septicæmia in removing the blood and filling the tissues through the circulation with fluid. Treat the cavities very thoroughly.

TUBERCULOSIS—CONSUMPTION.

Tuberculosis (consumption) is one of the most widespread and deadly diseases known. It is an acute infectious disease, due to the presence of the tubercular bacillus.

Morbid Anatomy.—Morbid changes very frequently take place in the larynx, trachea and bronchi. Tubercles usually develop first in the upper part of both lungs; sometimes, only in one. Their development is always, in a greater or less degree, associated with other morbid changes of the lungs; such as congestion and œdema of the lungs, bronchial catarrh, pneumonia, etc.

Cavities are usually found throughout the lung, from the size of a pea to the size of an orange; sometimes large enough to involve the whole lung. The pus from these cavities may have escaped into the pleura, or perforated the diaphragm, escaping into the abdomen. Pleurisy is an invariable complication, with effusion of serum or suppurative matter into the pleural cavities. There may be extensive pleuritic adhesion. Sometimes the morbid changes are very great in the intestines, peritoneum, mesenteries and other organs; such as ulceration of the intestines, abcess of the mesenteries, general or circumscribed peritonitis, etc.

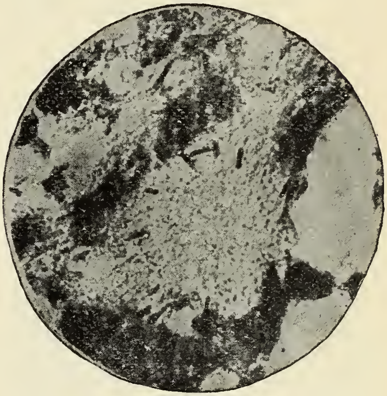

Fig. 25.

Bacillus Tuberculosus in giant cell, X 1000. From photomicrograph made at the Army Medical Museum, Washington, by Gray.

TREATMENT.

It must be remembered, in the treatment of these cases, that fluid does not reach the lungs through the pulmonary circulation, but by the bronchial arteries—branches of the thoracic aorta. Sometimes these are closed in the diseased portions of the lungs, when it will be impossible to supply the morbid material in that way with fluid. If fluid appears at the mouth or nose, it will

indicate that fluid is finding its way into the tubercular cavities, and that the morbid material will receive all that is necessary. To stop the leakage will require the occlusion of the trachea by the use of a tampon of cotton or lint. When fluid does not appear, inject fluid into the tubercular cavities through the trachea. Then follow with the usual methods of cavity treatment.

CHOLERA, ASIATIC.

Asiatic cholera is an infectious disease produced by the comma bacillus, or spirillum choleræ Asiaticæ. The comma bacillus was discovered, in 1884, by Koch, in the excreta of cholera patients and in the intestinal canals of bodies having recently died of cholera. The researches of Koch made in India and Egypt, and research made by various bacteriologists since that time, in different parts of the world, show that the comma bacillus is always present in the intestinal contents of cholera patients during the height of the disease, and that it is not found in the intestinal contents of those suffering from other diseases, nor in persons in perfect health.

Fig. 26.

Spirillum Choleræ Asiaticæ [comma bacillus]. From a culture upon starched linen at end of 24 hours, X 1000. From a photomicrograph by Fränkel and Pfeiffer.

The disease is characterized by violent vomiting and purging, with rice-water evacuations, cramps, prostration, collapse and other striking symptoms. It runs a rapidly fatal course, and is capable of being communicated to

others through the dejecta of patients suffering from the disease. These excreta are most commonly disseminated among a community, and taken into the system by means of drinking water or by anything swallowed which has been contaminated by the excretions from a patient suffering with cholera. In a dried state, the bacilli in cholera excreta may be carried in clothing to any point or distance where the disease may be communicated, as they retain their power of development for a long period of time, only requiring a "proper soil."

Morbid Anatomy.—The appearance is very characteristic after death in collapse of cholera. The whole body has a shrunken aspect, a grayish or leaden pallor, which contrasts with the livid hue of the lips, eyelids, ears, abdomen, back, fingers and toes. The eyes are sunken deeply in their sockets; the nose is bent and sharp; the temples are hollow, and the skin clings tightly to the bones; the tissues of the body are hard and dry, and, owing to the wasting of the softer parts, the muscles stand out prominently; decomposition takes place very slowly on account of the absence of moisture; rigor mortis is marked and persistent. The occurrence of muscular contraction after death is a very notable phenomenon. It may occur spontaneously, or, it may be excited mechanically. A case is reported by Eichhorst in which the fibers of the biceps muscle were noticed to move tremulously, and then the entire muscle contracted, causing flexion of the forearm, three hours after death. Even the fingers performed movements like those made in piano-playing. The lower jaw moves in some cases, causing the mouth to open and shut.

Barlow reports a case as follows: "The patient was a strong man; the course of his attack was rapid, and he suffered most cruelly from cramps. Within two minutes of his ceasing to breathe, muscular contractions began, becoming

more and more numerous. The lower extremities were first affected Not only were the sartorius, rectus, vasti and other muscles thrown into violent spasmodic movements, but the limbs were rotated forcibly, and the toes were frequently bent. The motions ceased and returned; they varied also; now one muscle moved, now many. Quite as remarkable were the movements of the arm; the deltoid and biceps were peculiarly influenced; occasionally the forearm was flexed upon the arm—flexed completely—and when I straightened it, which I did several times, its position was recovered instantly. The fingers and thumbs were now and then contracted, and at times the thumbs were separately moved. The fibers of the pectoral muscles were often in full action; distinct bundles of them were seen at intervals beneath the skin. After I had taken leave of the body, the nurse was horrified by a movement of the lower jaw, which was followed by others; and I thought for a moment that the man was alive. The facial muscles became generally affected, and at length all was still."

These contractions vary from slight trembling to powerful contraction of the muscle. Cases have been known to turn completely on the side by a strange and forcible combination of muscular contractions. These phenomena are not peculiar to cholera only. In cases of yellow fever they have been observed as well. In both diseases they occur when the cases are severe and rapidly fatal, and the patient is robust, with great muscular energy.

Stilla says: "On opening the abdominal cavity of persons who have died in collapse of cholera, one is struck by the general pink or rose tint of the peritoneal coat of the intestines. It is produced by a repletion of the minute branches of the portal venous system. Sometimes the color of the peritoneum is rendered very dark by the pitchy blood contained in the veins. The stomach generally

has a thin, partially transparent liquid of a greenish or grayish color. The intestinal canal is, in a majority of cases, partially filled with liquid which has the aspect of turbid serum, more or less mixed with the previous contents of the bowel, if death has taken place very rapidly, but otherwise it is almost colorless. In the more prolonged cases the contents at the upper part of the bowel are less liquid and are darker in color."

The comma bacilli are found in the intestinal contents, especially in the lower part of the small intestine, when death occurs at the height of the disease, also in the diarrheal discharges, but when the discharges become fecal or more solid the bacilli disappear.

TREATMENT.

Preservation of bodies dying from this disease should not be considered at all. A thorough embalment is necessary only as a sanitary measure. Disinfection of the body should be complete—internally as well as externally. First remove all clothing from the body and place it upon the board. Then pour a first class disinfecting fluid into the mouth and nostrils; soak a sheet in the fluid and wind it around the body, covering every portion. Raise an artery and fill the circulation full of fluid, forcing all that can be gotten into it. Then fill the intestinal canal and cavities of the chest and abdomen as full as possible. By this means the bacilli will be destroyed in a short time, rendering dissemination impossible.

All bodies dying from infectious disease, as directed elsewhere, should be thoroughly embalmed, if interment is to take place, as the bacteria may get into our water supplies by some means, or necessary disinterment may follow at some future time, greatly endangering a community. The above measures or cremation should be enforced by our health boards in these cases.

YELLOW FEVER.

Yellow Fever is a specific, infectious disease, so named from the yellow color of the skin which appears in the advanced stages of the severe forms of the disease and in the dead body. The infectious bacillus peculiar to this disease has not yet been determined, although it is supposed to exist in the intestinal contents. It is peculiarly a disease of the cities or where there is a density of population. It does not originate in country districts. It prevails in cities, on the shores of the ocean, along the large rivers and on ships. It neither prevails in a hot, dry nor cold climate. It matters not how violent the disease may be at any place, yellow fever will be arrested on the morning of a heavy frost or freeze. It seems that a hot, moist temperature is essential to its existence.

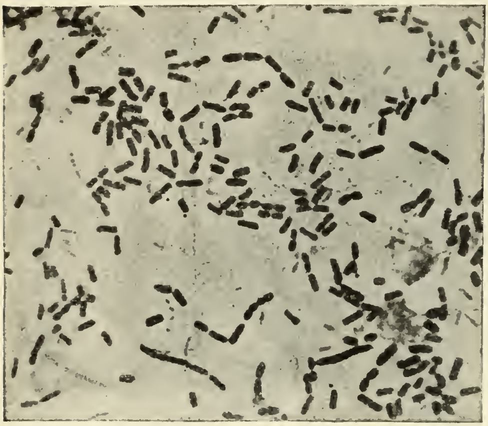

Fig. 27.

Bacillus Cadaveris. Smear preparation from liver of yellow fever cadaver, kept 48 hours in an antiseptic wrapping. From a photomicrograph (Sternberg).

Morbid Appearances.—In cases dying from yellow fever the features are frequently bloated; the skin of the face and upper portion of the body is of a golden-yellow color; while the dependent parts present a mottled purple and a yellow ecchymosed appearance. On section of the muscle a large amount of dark fluid blood escapes, which on exposure becomes bright scarlet. Putrefactive changes

may take place early, sometimes appearing to begin before death. However, in some cases, especially in those stricken with the disease in full muscular vigor, peculiar muscular phenomena take place, when the disease is severe and rapidly fatal, similar to those in cholera.

Dr. Dowler, of New Orleans, reports a case, as follows: "Not long after the cessation of respiration the left hand was carried by a regular motion to the throat, and then to the crown of the head; the right arm followed the same route on the right side; the left arm was then carried back to the throat, and thence to the breast, reversing all of its original motions, and finally the right arm did exactly the same thing."

All the vital organs and other viscera of the different cavities are affected more or less. The blood is altered in color and consistency. The secretions are changed. Bile is always absent from the intestinal contents. There is extreme congestion of the dependent portions of the lungs.

TREATMENT.

The same treatment should be followed as that given for cholera, and for the same purpose.

CEREBRO-SPINAL MENINGITIS.

In the exudate of cerebro-spinal meningitis, various micro-organisms have been found of the pathogenic type, which leaves little doubt that the disease is due to their presence.

Morbid Anatomy. — On observing the exterior of the body after death in the early stages there will be seen spots of transudation of blood into the tissues, especially in the dependent parts, where the patches are enlarged, and of a livid hue. The muscles are of darker color than natural.

There is congestion of the brain; its blood vessels are filled with dark blood, and the sinuses are usually filled with dark coagula. The ventricles are sometimes filled with purulent matter. Even all the space within the cranial cavity may be filled with purulent matter. Later in the disease the blood may become very thin. The same lesions will be found in the spinal cord that exist in the brain.

TREATMENT.

Blood should be withdrawn and fluid thoroughly mixed with it for the purpose of disinfection. Then, inject fluid by the Champion Needle Process, completely filling the tissues. Fill the cavities in the usual manner.

CHOLERA INFANTUM.

This disease is peculiar to infantile life. It attacks children under two years of age. Death usually occurs during the second or third day.

Post-mortem Anatomy.—Great emaciation is usually a result. Rigor mortis comes on quickly and passes off very soon. The mucous membrane of the intestines—both large and small—is of a dark-reddish color. There is more or less softening and injection of the cerebral tissues.

TREATMENT.

As these bodies commence decomposing soon after death, prompt treatment should follow. Inject the tissues full of fluid by the Champion Needle Process. Also, fill the cavities in the usual manner.

CHAPTER XX.

DISEASES AFFECTING THE BLOOD.

SEPTICÆMIA.

Septicæmia usually follows injuries, surgical operations, childbirth, erysipelas, carbuncles, burns, scalds, dissection wounds, etc.

The Morbid Anatomy of septicæmia has recently been very carefully studied, and as a result the most characteristic lesions are found in the blood and alimentary canal. The manifestation of blood poison is the rapid putrefaction of the body after death.

Rigor mortis comes on and passes off instantly. It may not be detected at all. Davaine defines septicæmia "as putrefaction of the living body."

Watson says: "It has also been observed that putrefaction in the human cadaver begins much sooner and progresses much more rapidly under similar circumstances when the death has been produced by this disease than when it has occurred from any other cause." "Furthermore, this rapid decomposition is not limited to the internal organs, but may be frequently strongly marked on the surface of the body after a lapse of a few hours."

When septicæmia originates in an external wound, putrefaction goes on most rapidly in the vicinity of the wound after death occurs. Coagulability of the blood is

diminished or destroyed. A few imperfect, deep-black colored clots of blood are found after death. The presence of this blood greatly hastens putrefaction of the soft tissues. Putrefaction goes on most rapidly in the dependent portions of the body — on account of the hypostasis — and along the course of the large veins.

Septicæmic blood is usually acid in reaction and always gives off a peculiar, putrefactive odor. Microscopy has shown that the blood and the various organs of the body contain, under these circumstances, a great number of the rod bacteria. Intestinal catarrh is always present.

TREATMENT.

In the treatment of septicæmic cases, it is highly important to remove at once all of the blood that is possible. This is best done by raising the femoral vein. The femoral vein is the most dependent, and more blood can be drawn by this method than by any other. After withdrawing all of the blood that is possible, let the vein remain open and commence the injection of fluid through the femoral artery. This operation will cause the blood to flow more freely through the vein, and when the fluid makes its appearance at the opening, tie the vein, and continue the injection until the circulation is entirely filled with fluid. Then fill the alimentary canal with fluid. This should be done by inserting the stomach tube through the mouth or nostrils, into the stomach; then, attach the aspirator and pump into the stomach and intestines from one to two quarts of fluid. This can be done by elevating the body to the sitting posture after the tube is introduced. Inject fluid around the other visceral organs of the abdomen and into the peritoneum; fill the pleural cavities and inject the lung tissues through the trachea. Remove all gases before proceeding to inject the body. Pump out and

refill the cavities; also, reinject the vascular system if necessary.

PYÆMIA.

Pyæmia is due to the entrance of septic products into the blood, and is characterized usually by the blocking up by clots, or emboli, of the arterioles of the lungs and other organs, and the consequent occurrence therein of scattered patches of congestion, hemorrhage, inflammation, suppuration, or gangrene. It results from either of the following causes: injuries, surgical operations, burns, scalds, erysipelas, carbuncles, dissection wounds, puerperal fever, etc.

Morbid Anatomy.—The external appearance of the body varies. In some cases the skin will be found everywhere to be of a dark orange or icteric tinge, and in others it will be pale, or anæmic, in appearance. Sometimes, livid black or yellow spots (produced by the effusion of blood into the areolar or fat tissues) exist on the surface of the body, and the edges of ulcers or wounds are generally of a blackish or dirty yellow color. If the disease has been protracted there is usually great emaciation. Rigor mortis is usually well marked after a few hours. There is diffuse suppuration in the cellular tissue, forming a thin and unhealthy pus, which is very liable to burrow. Sometimes suppuration takes place beneath the fascia of the tendons of muscles. Suppuration or gangrene may be found in any part of the body, but most frequently in the lungs and pleuræ. The pleural cavity may contain a large amount of purulent matter. Abscesses may be found in the liver, spleen and kidneys. Pus accumulates on the surface and in the Haversian canals of the bones, and forms in the joints. The blood in pyæmia is usually normal but it may contain the rod bacteria.

TREATMENT.

The treatment as given for septicæmia should be followed for the above disease.

PERITONITIS.

Acute, general peritonitis is an acute inflammation of the peritoneum. It may be primary or secondary. That is, the peritoneum may be attacked primarily or it may result secondarily from some other disease; such as inflammation or extensive ulcerations of the stomach or intestines, cancer, suppurative inflammations of the spleen, liver, pancreas and the pelvic viscera.

Perforation of the peritoneum occurs frequently and is followed by inflammation. It may result from external wounds, ulceration of the stomach or intestines, of the gall bladder, abscess of the liver, spleen or kidneys, appendicitis or inflammation of the ovaries.

Morbid Anatomy.—When the abdomen of a recent case is opened, the coils of the intestines are distended and glued together by lymph, and the peritoneum appears to be injected in patches and sometimes over the whole surface. Sometimes, there will be but little fluid present; only a thick exudation upon the walls. Then again, the intestinal coils will be covered with lymph, and there will be present a large amount of a yellowish, sero-fibrinous fluid. If the stomach or intestines be perforated, food and fecal matter may be mixed with the fluid. When purulent, the exudation is either thin and greenish-yellow in color, or opaque-white and creamy; if the material is putrid, the exudate is grayish-green in color, thin, and has a putrid odor. This usually results from perforative or puerperal peritonitis. If blood is present, it results in cases caused by wounds, cancer and tubercle.

The amount of effusion into the peritoneal cavity varies from one to fifty pints.

The different conditions are produced by some of the various species of micro-organisms.

Acute inflammation of the small intestine and colon, obstruction of the bowels and other diseases, may be mistaken for peritonitis, as their symptoms are similar. Such being the case, the physician's certificate may be misleading.

TREATMENT.

The treatment of cases of peritonitis should be thorough. After extracting the blood and injecting the arterial system, relieve the cavities of gas. Aspirate the contents of the peritoneum and other cavities and organs of the abdomen. Aspirate the chest cavities and fill them with fluid. After a few hours, withdraw the fluid from the abdomen and reinject as before. Place the body in a horizontal position, only elevating the head.

PUERPERAL OR CHILD BED FEVER.

Puerperal fever is an infectious disease, due, usually, to the septic inoculation of wounds resulting from childbirth. Pathogenic bacteria are always present.

Morbid Anatomy.—The morbid changes which take place in the inflamed peritoneum are precisely the same as those which attend inflammation of other serous membranes. The exudation from the surface of the peritoneum may form a false membrane, from one fourth to one half an inch or more in thickness. More or less fluid substance is found in the peritoneum. In many cases there is suppuration, pus being found in the peritoneal cavity. Pus or abscesses are found in the lungs and other organs, and in

the serous membranes, pleuræ, pericardium, etc. Septicæmia (blood-poisoning) may be the cause of death. Rigor mortis is very slight. Decomposition follows very quickly.

TREATMENT.

There are few cases which give more trouble than these; consequently, they require the closest attention, leaving nothing undone that will assist in the preservation of the body.

Gases being present in large quantities their removal should be the first operation. At the same time, the cavity of the abdomen should be filled with fluid. Next, make a thorough injection of the arterial system, leaving the tube in the artery, as a second injection may be necessary.

The blood should be withdrawn and the chest cavities injected. Make an incision over the pubic arch, in the median line, and pass the trocar into the cavity of the pelvis; attach aspirator, elevate the body well, and withdraw all the fluid previously injected into the cavity of the abdomen. Withdraw the trocar, sew up the opening, and reinject cavity of the abdomen. Have the body on the level while injecting, and so leave it.

Take cotton saturated with fluid and pass it up into the vagina — all it will receive. A thorough injection of the womb, through the vagina, before packing, would be an advantage. This may be done with a small curved instrument made for the purpose.

ERYSIPELAS.

Erysipelas is usually divided into simple cutaneous, celluo-cutaneous, and cellular or diffuse cellulitis.

Morbid Anatomy.—It is both infectious and contagious. The spread of erysipelas has been so frequently

observed, both in the sick room and in the wards of hospitals, that no doubt concerning the infectiousness of this disease can exist. Erysipelas also spreads by fomites. In erysipelas, as in other diseases of the zymotic class, it is believed a poison is absorbed that affects the blood; that, after a given period of latency, it generally, but not constantly, produces the phenomenon of fever which sometimes terminates in inflammation of the brain. The great specific action of the poison, however, is made manifest by inflammation of the skin and subcutaneous cellular tissue, which runs a definite course. The inflammation is usually of considerable extent, affecting very commonly the entire face, head, and neck, or a large portion of the trunk, or one or both of the upper or lower extremities.

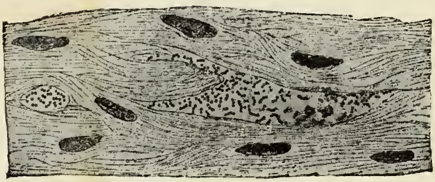

Fig. 28.

Section from margin of an erysipelatous inflammation showing streptococci, in lymph spaces, X 900. From a photograph by Koch.

In some cases the cuticle is raised into a large number of vesicles of greater or less size, and sometimes into large bladders containing transparent, yellowish serum.

Erysipelas sometimes terminates in gangrene. The skin becomes livid or black, its whole texture more or less disorganized, while these bullæ or bladders become filled with a bloody serum. The quantity effused is generally so great that the head, face, or limb is greatly and sometimes even hideously swollen.

TREATMENT.

These cases should be handled with gloves. Withdraw the blood by tapping the heart. Inject by the needle process; fill the cavities with all the fluid they will hold; pack the head or other affected parts on the surface with

hardening compound. Allow it to remain in this condition as long as possible. After removing the hardening compound, sponge the face over with fluid.

SUNSTROKE.

Another remarkable advance in medical investigation has been made during the past summer, and the cause of sunstroke, a subject until now obscure, has at length been definitely discovered. To the New York State Pathological Institute is due the credit of the discovery. These investigations show, that, instead of the sun's rays being the direct cause of sunstroke, as has all along been believed by the medical profession, as well as by the people at large, the fact is, the internal chemistry of the body and its secretions are so modified by atmospheric conditions of excessive hot weather that some of the secretions become abnormal, either in quality or quantity, and are absorbed by the blood and act as virulent poisons.

On the first day of the recent heat plague, Dr. Ira T. Van Gieson, director of the State Pathological Institute, assisted by Dr. Alexander Lambert and Dr. Lewis, began investigating. Their experiments were made with the brain fluids, the cerebro-spinal fluid, and the brain ventricular fluids. These were of acute cases immediately after death. The subjects had died in the hospital a few hours after being received there. Four rabbits died from the injection of these fluids within twelve hours. Other experiments were made with the blood of living cases just after they had been stricken by the sun, and there was no mistaking the fact that it was a deadly poison, as it killed in a very short time any animal into which it was injected.

Anatomical Characters.—The heart may be found firmly contracted, but not always so; it may be flaccid. The

lymph and the brain and its membranes are usually congested. The venous trunks and right side of the heart are too full of blood, and the pulmonary vessels may be overloaded with blood. The blood itself is very dark and more fluid than natural. Rigor mortis comes on very rapidly. The face becomes dark and swollen. The body retains a high temperature for some time after death. Gases form quickly, and purging and general decomposition soon follow.

TREATMENT.

To insure success, prompt and energetic work is necessary. The blood must be removed quickly and thoroughly. It is advisable to remove the blood by the femoral vein (using the femoral vein tube), injecting the fluid through the femoral artery at the same time. On account of the fluid condition of the blood in these cases, the greater part of the blood in the body may be forced out by the above operation. When all the blood possible has been removed, tie up the vein and continue the injection of the arteries as long as they will receive the fluid.

Then, make the cranial injection, putting in as much fluid as will pass in easily; after which, inject the lungs through the trachea, using about a pint of fluid. A thorough injection of the cavities should follow, putting in all the fluid they will hold. Allow the body to remain on a level as long as possible. The application, for a short time, of cloths saturated with fluid would assist in lowering the heat of the body.

GANGRENE.

This is a form of necrosis which especially attacks the lower extremities of old people, and is the result of several conditions.

Morbid Anatomy.—Arterial degeneration may, in itself, be sufficient to cause the arrest of the circulation, and the formation of thrombi or clots in the vessels of the limbs, thus causing gangrene. The supervention of the gangrene, however, is usually determined by some injurious stimulation of the tissues, as a slight abrasion of the foot, a bruise, injury to a corn, and excess of heat or cold, which sets up inflammation in the already weakened part. These, by still further obstructing the circulation thereïn, and impairing its vitality, cause death.

In a limb, for example, decomposition proceeds as follows: gases are generated in the part, principally sulphureted hydrogen, ammonia, nitrogen, and carbonic acid. The tissues, at the same time, undergo process of softening or liquefaction, the limb becomes exceedingly offensive, and, owing to alterations in the transuded coloring of the blood, changes from a reddish color to a brownish or greenish black. This is known as moist gangrene. It occurs only in external parts, and those internal organs to which the air is freely accessible, as the lungs. When met with in other situations, it is due to infection with septic matter.

TREATMENT.

The part should be washed with a four per cent. solution of carbolic acid, then thoroughly bandaged with hardening compound. The result will be a thorough disinfecting, deodorizing and hardening of the parts, so that under no circumstances will there be any unpleasantness. There is no treatment known to science that will produce such satisfactory results as will the above.

The injection of fluid, arterially, and by the cavities, should be done as in ordinary cases; as also should be the withdrawal of the blood.

POST-MORTEM CASES.

For the ordinary length of time that bodies are usually kept, a case may be treated successfully in the following manner: After thoroughly drying out the cavity, fill with hardening compound, completely surrounding the mutilated organs and viscera. When the body is to be shipped or kept for a length of time, if the brain has not been removed, inject the carotid arteries, tying the severed ends. The arms may be injected through the subclavian, right and left. The legs can be injected from the iliacs, right and left. If organs in the pelvic cavity have been mutilated, the femorals must be used. If the skull cap has been removed and the brain mutilated, fill the cavity surrounding the brain with hardening compound.

In case there should be cancerous tumors in the abdomen, do not remove but inject them with fluid and cover with hardening compound, when they will become hardened, as will also the viscera of this cavity. Sew up incisions carefully, and bandage.

CHAPTER XXI.

DISEASES OF THE AIR PASSAGES AND CHEST.

PNEUMONIA—LUNG FEVER.

Acute or Croupous.

Pneumonia (lung fever) is an infectious disease, to which the human family at all ages is subject. Children are equally susceptible to it with adults. It is the special enemy of old age. It attacks males more frequently than females. Weakened or debilitated persons are especially liable.

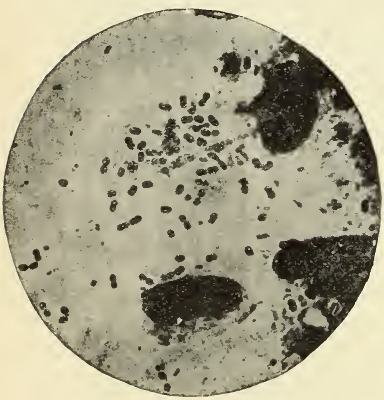

Fig. 29.

Micrococcus pneumoniæ crouposæ in sputum of a patient with pneumonia, X 1000. From photomicrograph by Fränkel and Pfeiffer.

Morbid Anatomy.—If death occurs early in the disease, during the stage of engorgement, the lung tissue is a deep red in color, and firm to the touch. On section, the surface is bathed with blood and serum and still contains air. Later, during the stage of red hepatization, the lung is solid, firm, and without air. It is much larger, and has indentations of the ribs on the surface, when an entire lobe is involved. On section, the surface is dry, reddish

brown in color, and readily broken down by the finger. The air cells are filled with fibrinous plugs; this is also often the case with the smaller bronchi. Very frequently the blood vessels are filled with solid molds of blood clots.

Still later, in the stage of gray hepatization, the tissue has changed from a reddish brown to a grayish white in color. On section, the surface is more moist, the exudation more turbid, and the tissue more easily broken down. In a more advanced stage of gray hepatization, there is purulent infiltration. The lung tissue is softened and bathed with purulent fluid. As a rule, the bronchi, at death, contain a frothy, serous fluid.

The smaller bronchi in the affected areas often contain fibrinous plugs which may extend into the larger tubes, forming perfect casts.

The pleural surface of the inflamed lung is nearly always involved. The exudation into the pleura may be considerable.

The bronchi containing frothy, serous material, results often in a purging of the same from the mouth and nostrils. Decomposition of the diseased portion of the lung is going on, even while rigor mortis is present, not to a great extent, but still enough to form sufficient gas for the driving out of this bloody, frothy matter. If we stop decomposition of the lung, and check the formation of gas, we shall have stopped this flow, or purging, of frothy matter.

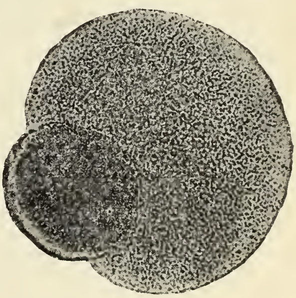

Fig. 30.
Single colony of micrococcus pneumoniæ crouposæ upon agar plate 24 hours old, X 100. (Fränkel and Pfeiffer.)

In pneumonia, the heart is distended with firm, tenacious clots. The distention of the right chambers of the heart is particularly marked. In no other acute disease do we meet

with such solid and firm coagula. It can be removed only by dissolving.

Inflammation of the pericardium (heart sac) frequently occurs, especially when the left lung is involved. The hepatic veins are often extremely engorged with blood.

TREATMENT.

The discoloration and purging, which are nearly always present in this disease, make these cases disagreeable, and sometimes difficult ones to handle satisfactorily.

First inject the arteries. As purging may come from the stomach as well as the lungs, it must be stopped by either of the following processes:

Pass a stomach tube into the stomach through the mouth or nostrils, and inject a small quantity of fluid. Attach aspirator and withdraw contents of the stomach, refilling with fluid; or, pass the trocar into the stomach from a point on the abdomen over the stomach, when the gases of the stomach will pass out, instantly stopping purging from that organ. Draw the skin up tightly and make an incision into the trachea, between the rings, at a point immediately above the breast bone; separate the rings with the tenaculum and introduce an ordinary curved nasal tube, and pass it down into the lungs. Attach syringe and inject about a half pint of fluid, first into one lung, then into the other. This may have the effect of forcing matter out into the mouth and nostrils. After having injected the lungs, attach aspirator to nasal tube and remove all the fluid matter possible. Reinject fresh fluid, and the chances are very much in favor of your having no further trouble in this direction.

If, however, there is still purging, insert the trocar at the point used for tapping the heart, and force it in different directions upwards and through the lungs as far as

the upper end or apex, when all danger of purging will be past.

You may possibly have some trouble in drawing blood, on account of its coagulated condition in the heart. If so, inject into the right auricle a small quantity of a salt solution ; then aspirate.

The pleural cavities may be injected from the same point as used for tapping the heart. In a great many cases but a small quantity of fluid can be injected into these cavities, as the lungs become greatly distended, completely filling the cavities.

The cavity of the abdomen should receive thorough treatment, as very often the viscera in this cavity is involved.

Inexperienced embalmers, writing on the treatment of pneumonia cases, advise the tying of the trachea and gullet with tape, in order to stop purging from lungs and stomach. None but the merest tyros would pay any attention to such advice.

GANGRENE OF THE LUNGS.

Upon post-mortem examination, the morbid changes will consist of a cavity, irregular in outline, with ragged walls, sometimes containing loose fragments of lung tissue, or a dirty greenish or brownish mass of material with the regular gangrene odor. The cavity is usually in the middle or lower lobe of the right lung.

TREATMENT.

In the treatment of a case of this kind fluid should be injected into the lung through the windpipe several times, at intervals of two or three hours. Treat the arteries and cavities in the usual way.

PLEURISY—PLEURITIS.

PRIMARY PLEURISY.

Primary pleurisy does not often produce death. We usually have pleurisy to deal with as a complication of some other disease.

Morbid Anatomy.—But where death does occur from primary pleurisy, there will be found a large amount of effusion in the pleural cavity or cavities, having the appearance of diluted blood, which coagulates when it comes in contact with the air. Sometimes the lung is collapsed, and the heart is pushed to one side; even the face and surface of the body will appear as if death had been caused by asphyxia.

PURULENT PLEURISY; SOMETIMES CALLED: PYOTHORAX, EMPYÆMIA, SUPPURATIVE PLEURISY, OR CHRONIC PLEURISY.

This is a disease of the pleura which secretes pus instead of the bloody-like appearing fluid as described above.

Morbid Anatomy.—This disease is usually found accompanying wounds of the chest, fractures of ribs, abcesses of the walls of the chest, and gangrene of the lungs. It is also frequently found in measles, smallpox, scarlet fever and all diseases of the lungs. Therefore, when death occurs from either of the above diseases, the pleural cavities must be carefully examined and treated. Under these circumstances the liquid is either thin or thick pus. It will become putrid in a very short space of time, gases forming quickly, causing putrefaction of the surrounding tissues. Children as well as adults are attacked.

TREATMENT.

Treatment should be prompt and vigorous. The pus and liquid contained in the pleural cavities should be

withdrawn with the aspirator at once. This is very important and under no consideration should it be neglected. Introduce the trocar at the same point as that in tapping the heart, passing it down into the lower part of each pleural cavity, aspirate their contents and fill with fluid. Then follow with the usual treatment, filling the arteries and withdrawing the blood and filling the cavities.

PERICARDITIS.

Inflammation of the Pericardium.

Morbid Anatomy.—The morbid appearances resulting from inflammation of the pericardium are essentially the same as those seen in other serous sacs. Exudation of fibrin or lymph has taken place in more or less abundance and is deposited in layers on the parietal and visceral surface of the membrane. More or less liquid effusion of serum, turbid from the admixture of lymph, is found in the sac, sometimes in enormous quantities amounting to eight or ten pints. Sometimes the walls are partially adhered to each other, and at others the amount of effusion is so great as to fill the greater part of the thoracic cavity and push the diaphragm downwards.

TREATMENT.

The effusion must be aspirated as well as the blood. The cavity of the sac must then be filled with fluid. The arteries and cavities should be filled with fluid as in ordinary cases.

PNEUMO-PERICARDITIS.

This name denotes the presence of air or gas within the pericardial sac in cases of pericarditis. Air or gas may find its wav into this situation through a wound of the chest

walls, or of the esophagus, and through a fistulous communication between the lungs or the stomach and the pericardial cavity. It is possible that gas may be generated quickly by putrefaction of inflammatory products within the cavity.

TREATMENT.

It matters not what the cause may be that produced the gas, it should be removed and the sac filled with fluid. Otherwise, the case should be treated as indications require.

VALVULAR DISEASES OF THE HEART.

Morbid Anatomy.—Valvular lesions of the heart are situated, in the great majority of cases, in the left side of the heart at the mitral and aortic openings. Lesions on the right side are comparatively rare. The valves are frequently thickened and contracted; or, they may simply be encumbered with vegetations of greater or less size, without being incapacitated for the performance of their function. They are sometimes rendered more or less rigid by the deposit of calcareous matter. The aortic and mitral valves may become enlarged and thickened sufficiently to almost close the orifices, or they may become atrophied, rendering them liable to rupture or perforation. Enlargement of the heart follows either of the above conditions. When the aortic valves are diseased sufficiently to interfere or prevent perfect closure of the aortic orifice, fluid, when injected through the arteries, will enter the left side of the heart, and if, in tapping the heart, the left side be perforated by the trocar, a partial destruction of the circulation will result and the fluid fail to permeate a part at least of the tissues. The lungs may become involved, resulting in œdema, hemorrhages, or pulmonary apoplexy. Dropsy of

the serous sacs or general dropsy may be present. Death may have been caused by heart failure or apoplexy. The face and upper surface of the body is congested and edematous, rendering the removal of blood necessary.

TREATMENT.

In tapping the heart care should be taken not to wound the left side as it may interfere with the circulation of the fluid, but such cases are not frequent. It is only when the semilunar valves at the aortic orifice are diseased that trouble will result. Mitral disease will not affect the circulation of fluid. The patient may have died from asphyxia, as a result of œdema of the glottis, hydro-pericardium, or pulmonary congestion. Congestion of the face and neck will be produced. The blood must be removed at once. The water must be taken from the cavities and subcutaneous tissues. Treat the lung tissues through the trachea; fill the thoracic and abdominal cavities with fluid. The arteries should be filled by a thorough injection. Handle the body with care for a time, until the skin hardens. The alimentary canal should not be neglected. Chemical and putrefactive changes take place early in these cases, therefore, prompt and heroic treatment should be given, in every case.

OTHER DISEASES OF AIR PASSAGES AND CHEST,

SUCH AS LARYNGITIS, BRONCHITIS, ETC.,

Should be treated as all other ordinary cases, except that fluid should be injected into the throat and trachea.

CHAPTER XXII.

DISEASES AFFECTING THE ALIMENTARY CANAL.

OBSTINATE CONSTIPATION.

This is caused by intussusception, torsion or knotting of the bowels, foreign bodies, or stricture.

Morbid Anatomy.—The skin usually has an icteric or sallow appearance. The color of the contents—half digested food, as partly altered milk, meat, or vegetable matter—of the intestinal canal and stomach, is brown, black, dark green or yellow. The colon is distended sometimes as to almost fill the abdomen. Ulceration of the mucous membrane and perforation of the wall of the gut sometimes follow with extravasation into the abdominal cavity. Peritonitis may result. Abscesses may form in the cellular tissues around the rectum. The accumulation of fecal matter in the sigmoid flexure may be very excessive. Peacock reports a case where fifteen quarts of semi-solid, greenish-colored, fecal matter were removed at the autopsy. Samazurier reports one of thirteen and a half pounds, and Chelins one of twenty-six pounds. Bristowe reports one where the whole length of the colon, from the anus to the cæcum, was filled with semi-solid, olive-green colored feces, and the small intestine was filled throughout with semi-fluid, olive-green contents. In composition the mass

consists of fecal matter with unaltered vegetable fiber. They may be partly composed of the skin of grapes, cherry-stones, biliary calculi, hair, woody fiber, magnesia or other foreign substances.

TREATMENT.

After removing the gases, withdraw the blood and fill the tissues through the arteries. Then treat the viscera very thoroughly. If the colon is filled with semi-fluid and semi-solid matter, remove if possible by aspiration. The matter should be removed at all hazard, even if an incision has to be made in the median line above the pubic arch for its complete removal. After aspiration, fill the stomach and intestines and inject fluid around the organs and fill the abdominal cavity. Then place the body on the level, elevating the head.

DYSENTERY—FLUX.

Dysentery is inflammation of the large intestine, attended with mucous and bloody dejections.

Morbid Anatomy.—In severe cases, the inflammation is very extensive, involving not only the rectum, but the greater part of the colon. The affected membrane, on examination after death, is found to be reddened, congested, swollen, softened, pulpy, presenting, in different cases, ecchymoses, excoriations, from pealing off of the epithelium, abrasions, and ulcerations in greater or less numbers, the latter being sometimes small and sometimes of considerable size. The ulcers may or may not be seated in the internal glands. The swelling of the membrane is due to submucous infiltration, and the latter is sometimes so great, at certain points, as to give rise to protuberances resembling warty growths. The protuberances may be

more or less numerous, and sometimes coalesce, giving to the surface a lobulated appearance. Patches of exuded fibrin are frequently adherent to the inflamed membrane, presenting a greenish or brownish color. The intestine contains more or less morbid life, consisting of mucous, pus, fibrinous flakes and bloody serous liquid. The intestine may present a dark, almost black, appearance from congestion. Sloughing and ulceration is present. As a rule, the appearances denote progressively a greater amount of disease in passing from the upper part of the large intestine downward to the anus; the greater amount being in the rectum and sigmoid flexure of the colon.

The mesenteric glands are sometimes considerably enlarged, and in some instances contain pus.

TREATMENT.

This disease seems, generally, to be confined to the large intestine. Sometimes, when the mesenteries become involved and ulcerations take place higher up in the colon, peritonitis results. If the latter condition is present, the peritoneum must be treated as directed in the general treatment of peritonitis. Gases must be removed from the large intestine, which should be filled with fluid. Other visceral organs must be treated as usual. A thorough arterial injection should be made.

APPENDICITIS.

Inflammation of the Appendix Vermiformis.

Appendicitis is an inflammation of the vermiform appendix. It is located in the right iliac region.

Morbid Anatomy.—Ulceration may occur and result in perforation into the surrounding tissues, including the

peritoneum. Violent suppurative peritonitis will follow perforation of the peritoneum. Pus may pass into the tissues behind the peritoneum and form a large perinephritic abscess; or pus may pass downward along the psoas muscle, forming abscesses in the gluteal region. A large amount of tissue may be involved in the lower part of the abdominal cavity and frequently requires heroic treatment.

TREATMENT.

Give the body a thorough arterial injection. Treat the organs of the chest in the usual manner. The abdominal organs should be treated very carefully, especially the region of the right lower part, and the pelvic cavity. Before injecting the abdominal cavity aspirate the pus and blood, if any be present, from the peritoneum and the region of the cæcum.

HERNIA OR RUPTURE.

The morbid changes in hernia or rupture are similar to those in Appendicitis, and similar treatment is required.

SPORADIC CHOLERA—CHOLERA MORBUS.

This is an affection of the mucous membrance of the stomach and intestines, characterized by violent pain in the abdomen, nausea, violent and incessant vomiting, and by purging of watery fluid. This disease rarely proves fatal, although a state approaching collapse sometimes occurs, but is usually followed by reaction. It is not contagious.

Morbid Appearances.—Even when the symptons are the most severe during life, we do not always find morbid changes sufficient to account for the cause of death. There

are, however, usually evidences of gastro-intestinal catarrh; the mucous membrane is congested throughout. The solitary gland and Pyer's patches are swollen and prominent. The blood is dark and thickened. The appearance may resemble that of Asiatic cholera. The kidneys are congested and enlarged.

TREATMENT.

The treatment should be thorough. The blood should be removed and the tissues filled with fluid. The cavities should be filled in the usual manner. Pay especial attention to the stomach and intestines.

OTHER DISEASES OF THE ALIMENTARY CANAL.

SUCH AS GASTRITIS; ENTERITIS, COLITIS AND ENTERO-COLITIS, USUALLY KNOWN AS INFLAMMATION OF THE BOWELS, ETC., ETC.

The morbid changes are confined to the parts affected, except when perforation or extensive and deep inflammation exists, usually involving the peritoneum, causing peritonitis, as in inflammation of the stomach and intestines, both large and small. Cancer may involve the liver, spleen, pancreas, kidneys and bladder.

TREATMENT.

In all such cases treat the abdominal cavity very thoroughly, besides the usual general treatment of the vascular system. The stomach and intestines should be filled with fluid.

CHAPTER XXIII.

DISEASES OF THE KIDNEYS.

BRIGHT'S DISEASE—ALBUMINURIA.

Bright's disease of the kidneys is of three forms: inflammatory (acute and chronic), waxy or amaloid, and cirrhotic or gouty.

Morbid Anatomy.—As a result we have atrophy, fatty degeneration, hypertrophy, diminution of urine, albuminuria, hematuria, dropsy, etc.; also, later changes in the heart and blood vessels and other organs, waxy disease of the liver, spleen and intestinal canal, hypertrophy of the heart, œdema of the lungs, etc. The kidney may reach twelve ounces in weight, or it may be reduced in weight and size to one and a half ounces. In addition to the above, other organs become affected. There is usually great pallor of the surface. Œdema of the surface in general dropsy is present; also, œdema of the lungs and glottis, pleural effusion, mitral regurgitation (disease of the mitral valves of the heart), abdominal dropsy. Dropsy is always present to a greater or less degree. The serous cavities and subcutaneous tissues may be filled with water to the greatest distension, or, there may be only a slight effusion in the tissues, sufficient to cause softening of the rete mucosum and resulting in "skin-slip." Pneumonia, pleurisy, gastritis. etc.. may accompany this disease.

TREATMENT.

The treatment should be thorough. Remove all of the water as directed in the treatment of dropsies. The ultimate cause of death may have been asphyxia, resulting from œdema of the glottis. If such is the case there will be congestion of the peripheral veins. The blood must be withdrawn and fluid injected slowly into the arterial system; fluid should also be injected into the cranial cavity. Treat the lung tissues through the trachea, and inject the pleural cavities. The alimentary canal and other viscera of the abdomen should receive careful and thorough treatment. Water may be present in the tissues sufficient to cause the skin to slip, but not enough to cause œdema of the surface. If the skin is inclined to slip, handle the case carefully and after the water has evaporated and settled to the dependent parts of the body, it will harden and become firm in a few hours. After treatment, place the body on a level with only the head elevated.

NEPHRITIS.

Inflammation of the Kidney.

Dropsy is always present. May be slight or excessive. Otherwise the body will be in a similar condition as in Bright's disease, and will require similar treatment.

DIABETES.

Sugar in the Urine.

Diabetes is not a disease of the kidneys as was formerly supposed. These organs merely excrete sugar contained in the blood brought to them by the renal arteries. The sugar in the blood increases the functional activity of the

kidneys, acting like a diuretic, and hence the quantity of urine is greatly increased.

Morbid Anatomy.—This disease has no constant anatomical characters, aside from lesions belonging to concomitant or consecutive affections. The kidneys are often enlarged or hypertrophied, atrophied, or contain abscesses. The blood contains sugar. It has been found in the saliva, in the infusions, in the serous cavities, in the humors of the eye, and in the spermatic fluid. Pulmonary affections are frequent complications, such as pneumonia or tuberculosis. Desquamation of the cuticle often occurs. Boils and sometimes large abscesses are found in different parts of the body; also, gangrene, or ulceration without gangrene, of the lower extremities. Œdema of the legs often occur.

TREATMENT.

The treatment in these cases depends entirely upon the amount of tissues involved by complication. Inject the vascular system and cavities thoroughly in every case. If dropsy is present, which is frequently the case, adopt the usual means of removing the water from the tissues. If abscesses or gangrene are present, use hardening compound, as directed under the head of gangrene. These cases should be handled carefully. The tissues being filled more or less with water there is a liability to "skin-slip."

DISEASES OF THE BLADDER.

The bladder may be the seat of the following morbid conditions: inflammation and acute or chronic abcess; atrophy or hypertrophy; mechanical distension with chronic engorgement; the retention of urine; tumors or growths; epithelioma and carcinoma; tubercular disease; ulceration; vesico-vaginal or vesico-intestinal fistule. It may contain blood or purulent material.

TREATMENT.

The trocar should be introduced immediately above the pubic bone in the median line, directing it inward and downward to reach into the bladder. Withdraw all liquid matter and inject fluid, mixing it thoroughly with the contents; then, withdraw the same and inject fresh fluid, filling the organ as full as possible. Otherwise, the body should be treated in the usual manner.

CHAPTER XXIV.

DISEASES OF THE NERVES.

PARALYSIS.

This is the loss of the power of motion, or ot sensation, or of both motion and sensation. The different forms of paralysis of common occurrence are due :

(1) To disease of the brain, in which form the muscles may be rigid or relaxed, the disease of the brain being the result of syphilitic poison, the epileptic or chronic state.

(2) To pressure upon or injury to a nerve.

(3) To diseases of the spine.

(4) To the influence of poison, such as have arsenic and mercury.

Morbid Anatomy.—Paralysis having its origin in one side of the brain is characterized by a very prominent feature, namely, one-sidedness. This phenomenon constitutes that form of paralysis called hemiplegia, or paralysis of one side of the body, from disease of the opposite half of the brain.

Lesions which give rise to hemiplegia are :

(1) Softening. If a clot or abscess in the corpus striatum, or optic thalamus, or in the immediate vicinity of these parts, produces pressure upon these central ganglia, or centres of volition, or if the fibers be otherwise interfered with, paralysis will result. The center of volition

reaches from the corpora striata in the brain down the entire length of the anterior horns of the gray matter of the spinal cord, and includes the locus rigor in the crus cerebri of the mesocephalin and of the medulla oblongata. Disease of any part of this center, or range of structures, is capable of producing paralysis.

(2) The intra-cranial portion of the above range exercises the greatest and most extended and complete paralysis, and takes place from disease of the intra-cranial portion.

(3) In cases of central disease, it must be observed and remembered that the intra-cranial portion of the center of volition for the left side of the body is situated on the right side, and that for the right side is situated on the left side of the cranium, while the intra-spinal portions maintain, relatively, their respective sides. These two portions are connected by the oblique fibers from the anterior pyramidal column of the medulla oblongata, which crossing from right to left, decussate with similar fibers proceeding from left to right.

(4) Exudations, which are the result of inflammatory or other diseased state of the membranes of the brain, which, as they increase and cause pressure on the surface, transmit the effects of pressure downwards to the corpus striatum and optic thalamus, and thus cause paralysis.

(5) Morbid states, which affect or destroy fibers of deeper seated parts, such as the crura cerebri, or of the cerebellum in its crura (because a connection exists between the hemisphere of the cerebellum and the fibers of the pyramids in the pons Varolii), cause paralysis.

Of the different forms of paralysis of motion, those known as paraplegia and hemiplegia require more prominent illustrations.

Paraplegia is a form of paralysis affecting the lower half of the body only, in which both legs and perhaps also

some of the muscles of the bladder and rectum are paralyzed.

Hemiplegia is a form of paralysis affecting one lateral half of the body. It is that form of paralysis to which the name of paralytic stroke is commonly applied. Either half of the body may be affected, and the parts which are actually involved are generally the upper and lower extremities of one side, the muscles of mastication, including the buccinator, and the muscles of the tongue on one side. The paralysis may be either complete or incomplete, as regards motion power.

The special lesions of the brain, causing hemiplegia are:

(1) Obstruction of a principal, central artery by a plug of fibrin, detached from an excrescence on one of the aortic or other valves of the heart, the result of a former endocarditis.

(2) A coagulum formed in an artery, resulting from some altered nutrition of its wall, and connected in general with rheumatic or other morbid state of the blood.

(3) A softened state of the brain, such as the condition known as white softening, which follows the retardation and diminution of cerebral circulation by diseased arteries, or by the complete stoppage of an artery by a plug.

Anæsthesia, or paralysis of the nerves of sensation, may result from disease:

(1) Of the cerebrum, where the fifth nerve takes its origin.

(2) Of the nerve within the cranium.

(3) Of the nerve after it has emerged from the cranium, and ascended to the seat. The symptoms vary.

The disease may be in consequence of some injury, such as the extraction of a tooth. Dissections show that condensation, atrophy, softening, and the pressure of tumors, are the morbid conditions out of which the anæsthesia springs.

TREATMENT.

Paralytic cases being invariably very much emaciated, the operator often makes the mistake of using only a small quantity of fluid. It is at times difficult to inject into the arteries very much fluid on account of the obstructions in the vessels. If any trouble is experienced in injecting an artery on one side, allow the incision in the artery to remain open and operate on an artery on the opposite side. For instance, if the right radial or brachial were opened and a successful injection did not result, open the same vessel on the left side. If fluid did not pass out of the first opening by the injection of the second, that would be evidence that there was no circulation in the vessels in the right arm. If the vessels of the face were not distended by the injection of the artery in the arm, that would indicate the fact that there was no fluid going to these parts. An injection through one of the carotids would then be in order; inject very slowly upwards until the vessels show distention; then reverse the tube and inject towards the heart, putting in all the fluid the vessels will receive without much pressure. The Champion Needle Process should then be used, injecting slowly, with the body in an elevated position, as much fluid as will pass in easily. Careful attention must be given the parts that it is thought have not received the fluid (hand and arm first operated on). The lungs and cavities of the chest should be treated, and a thorough treatment of the abdominal cavity is necessary. Inject into it all the fluid it will hold, keeping the body on the level as long as possible. When bodies of this kind are to be kept for a long time, or shipped to a distance, a complete bandaging with hardening compound would be advisable, as seldom if ever is the fluid brought to the surface by arterial injection; hence, the softened condition of the exterior, which may be prevented by the use of hardening compound.

APOPLEXY.

The liability to apoplexy has a manifest relation to age. The liability increases from the age of twenty years upwards, and in the majority of cases, the age of those attacked is over sixty. Males are more subject to this affection than females.

Morbid Anatomy.—In fatal cases of apoplexy, the most frequent pathological condition is hemorrhage within the cranium. An examination, when death has followed in a few hours after extravasation, shows a clot with bloody serum contained in a cavity produced by laceration of the substance of the brain.

Microscopical research has appeared to show that hemorrhage into the substance of the brain is generally the result of either fatty or calcareous degeneration of the coats of the smaller cerebral arteries. Owing to their weakness or brittleness, rupture or fracture is liable to occur.

TREATMENT.

Owing to the discoloration of the face, ears and neck, always existing in these cases, and the tendency of the blood to coagulate quickly, the first operation should be the withdrawal of the blood by the most convenient method. If discoloration remains, apply the ice poultice as directed elsewhere.

There is no advantage over that of arterial injection to be gained by any of the needle processes. The injection at any point should be made very carefully, using as little force as possible; take time, and work slowly. In ordinary cases a quart or two of fluid, injected arterially, is usually sufficient. If more should be necessary, as in preparing for shipment, make a second injection, allowing some hours to intervene between the first and second. Treat cavities in the usual manner.

CHAPTER XXV.

SPECIAL DISEASES.

ALCOHOLISM.

The experienced inquiry and pathological observations, on the bodies of known drunkards, by Dr. Roesch and Dr. Francis Ogston, are contributions which have placed on a surer foundation our previous theoretical information regarding the morbid status, which follows the persistent use of alcohol. The term alcoholism is used to denote various symptoms of disease attending morbid processes of various kinds, which are capable of being traced to the use of stimulants containing alcohol. The immediate effects of intemperance — as it is commonly called —, the nature of delirium tremens and of spontaneous combustions, may be embraced under the general designation of alcoholism. The pernicious effects of alcoholic stimuli in excess on the organs and tissues of the body have been deduced from a careful study of the morbid appearances of a chronic kind, met with in the bodies of individuals known to have lived intemperate lives, and who had perished suddenly from the effects of accident, suicide or homicide, and while apparently in ordinary health and activity. The extent of such chronic change in the various organs of such individuals are found to have been far in excess of what could have been usually looked for in a like number of persons

of the same age and of temperate habits, suddenly cut off, while apparently in average health and vigor.

The cumulative effects of long-continued intemperance have been clearly proved by Dr. Ogston's observations; and the results of his post-mortem inspections, on the whole, support the conclusions which have been arrived at. The following statements contain a summary of these results:

(1) The nervous centers present the greatest amount of morbid changes, the morbid appearances within the heart extending over ninety-two per cent. of those examined. By this observation the theoretical remarks of Drs. Craigie and Carpenter are clearly established.

(2) The change in the respiratory organs succeed in frequency those of the nervous centers, yielding a per centage of 63.24 of those examined.

(3) Morbid changes in the liver are most in order of frequency and are due to enlargement or granular degeneration. The nutmeg-like congestion comes next, and lastly the fatty state.

(4) Next to changes in the liver come those in the heart and large arteries.

(5) Least frequent of all are morbid changes in the alimentary canal.

Two orders of changes may be observed to result from intemperance in the use of alcoholic fluids: namely, one set of long duration, or which at least must have taken some considerable time before they could be completed; another set of shorter duration, and which probably are more closely connected with the immediate symptoms which precede the fatal event. The abnormal changes in the cranium, the substance of the brain, its convolutions, and cerebral ventricles. all indicate the prolonged action of a morbid poison. The prolonged action of the alcoholic

poison on the cranial contents is to produce induration of the cerebral and cerebellar substance in by far the greatest number of cases coincident with an increased amount of subarachnoid serum; and the steatomatous degeneration of the small arteries leads to atrophy of the convolutions and œdema of the brain.

When spirituous liquors are introduced into the stomach, they tend to coagulate in the first instance all albuminous articles of food or fluid with which they come in contact; as an irritant they stimulate the glandular secretions from the mucous membrane and ultimately lead to permanent congestion of the vessels, to spurious, melanotic deposit in the mucous tissue, and to the thickening of the gastric substance. By the veins and absorbents of the stomach, the alcohol mixes with the blood, and immediately acts as a stimulant to all the viscera with which it is brought in contact. The functions of the brain are at once stimulated and ideas follow in more rapid succession; the liver is excited to secrete an excess of sugar by the immediate action of the stimulant on its tissues. The flow of urine is excited in a similar manner, and in these effects it is impossible not to recognize the operation of an agent most pernicious in its results. The mere coagulation of the albuminous articles of food and fluid is very different from that effected by the gastric juice.

Positive irritation very soon succeeds the intemperate use of alcohol. It is manifested in a variety of ways; sometimes by an unnaturally voracious appetite, and those who over-indulge in the use of such stimuli subsequently suffer a total disrelish for food. They become unable to eat, and dyspeptic symptoms of various kinds betray the irritated state of the alimentary canal, such as stomach ache, vomiting, frequent generation of gases, waterbrash, heartburn, syncope and palpitations, a constipated condition of

the intestines, attended with deficient secretions of bile, which is known not to be secreted in due quantity. If one follows the course of alcoholic absorption through the vascular and pulmonary systems, it is found unquestionably to retard the motion of the blood, while it produces a temporary increase in the action of the heart and a congestion of the whole system of the pulmonary capillary vessels. In the case of habitual spirit drinkers there is thus constantly going on a temporary stimulus and quickened motion of the blood through the vessels, especially manifested by cerebral, thoracic and hemorrhoidal phenomena, followed by a corresponding depression and tendency to stagnation of the blood in the capillaries of all the internal organs, especially in the membranous tissues and the lax areolar tissues of dependent parts. The most common form of alcholism is that about to be noticed, namely,

DELIRIUM TREMENS.

This disease has only been known and described since the beginning of the century. The essential nature of the affliction is associated with the loss of the cerebral power in the control of thoughts, emotions and muscular action, consequent to an over-excitement by alcoholic stimuli, and sometimes immediately dependent upon the diminution of the degree of excitement to which the brain has been accustomed. With this form of deliriums, there is always associated more or less derangement in several other functions. The patient is generally void of all appetite, or may even be squeamish and vomit at intervals; sometimes, he is thirsty and calls loudly for liquor. In some cases, great aversion and even dread of food and drink is evinced and it is impossible to persuade the patient to partake of either. There is generally fulness or distension and

not unfrequently tenderness and pain in the epigastric, umbilical and right hypochondriac regions. The skin is bathed about the head and neck with a clammy, unctuous, cold moisture. The pulse varies from 96 to 120, or more. The carotid and temporal arteries beat more violently, the action of the heart is unusually violent, and the cardiac beat is diffused over the entire chest. After symptoms of restlessness and sleeplessness have continued for three or four days, the patient may either fall into a sound sleep, which lasts for hours and proves a crisis; or, on the other hand, the symptoms may pass into a state of coma rigor, the pupil becomes contracted, the muscles of the face and jaw are moved incessantly, and death may ensue from prolonged coma or convulsions. The duration of the disease varies from three or four to seven days, and a favorable or fatal termination may result in from three to four. The greatest mortality is between the ages of twenty-five and fifty.

The apparent cause of death in sixty cases was as follows: Thirty-three by exhaustion (often with coma); sixteen by coma; ten by fits (sometimes apoplectic); one found dead in bed.

Convulsions occurred in at least twenty-four of the above cases.

TREATMENT.

These cases are to be distinguished from typhoid fever and from paralysis agitans by the previous history of the case. When the case is one that has been a habitual drunkard, the conditions are similar to typhoid fever and require very thorough treatment. The conditions of the arteries are very often such as to prevent a successful injection of the vascular system, and, as all the organs contained in the cavities of the abdomen and chest, as well as the brain, are involved, a most thorough treatment of

them is absolutely necessary. The Champion Needle Process should be used for the purpose of introducing the embalming fluid into the brain tissues; as much fluid as the arteries will receive should be introduced into them. The blood should be withdrawn by one of the processes given. The lungs should be filled by the injection of the trachea. Sometimes there is an effusion in the lung cavities; aspirate to determine that fact: then, fill the cavities with fluid. The stomach should be injected by the esophagus with a stomach tube. The cavity of the abdomen should be injected to distention, allowing the body to reremain perfectly level as long as possible, that the fluid may be kept in contact with the liver, spleen, pancreas and kidneys. A second injection after six or eight hours would be advisable, after aspirating the fluid first injected into the abdominal cavity.

DROPSY.

Dropsy is always the result of some other morbid condition, as heart disease, liver disease, kidney disease, etc. It is not a disease *per se*, but only a symptom of disease.

Morbid Anatomy. — Dropsies receive their names from their situations. If seated in serous cavities they are designated by prefixing "*hydro*" to the name of the serous membrane. Dropsy of the areolar tissue is called œdema, as œdema of the glottis, or œdema of the legs, arms, face, etc. An effusion into the air cells is called œdema of the lungs. An effusion of the abdomen is ascites, or abdominal dropsy. When œdema is general over the surface of the body, it is called anasarca. When an effusion is found in all parts of the body, it is called general dropsy.

Frequently death is caused by asphyxia, as from œdema of the glottis, hydro-thorax, etc.

When death is caused by asphyxia, the peripheral veins will be congested, with extensive discolorations of the face and neck. In general dropsy, the cavities and subcutaneous and areolar (fat) tissues are all filled with fluid, more or less, in every part of the body. The cavities sometimes will be filled to great distention, especially the abdominal cavity. It may contain many quarts of water. From distention of the pleural sacs, the lungs may be collapsed and the heart pushed out of position. The forearms, hands, legs, feet, and other parts, may be distended to an enormous size. The cuticle will have a tendency to loosen and slip, on account of the softening of the rete mucosum, the pigment layer between the cuticle and the true skin.

A case of general dropsy, of the severe type, is one which frequently tries the skill of the embalmer and should be thoroughly treated.

TREATMENT.

Place the body on an embalming board, well elevated, over which has been placed a rubber cover. Roll up the sides of this to prevent fluid matter from soiling the carpet. Bring the lower end corners of the cover together so as to form a spout, underneath which place a vessel to receive the water from the body.

The most common kind of dropsy is that of the abdomen. To relieve the body of water, in this instance, make an incision in the lower part of the abdomen, immediately over the pubic bone. Insert trocar, pointing upwards, and into the space containing the water. Attach pump and aspirate contents.

It may be, the case is one where water also may be located in the cavity of the abdomen, floating the intestines and stomach. To relieve this condition, pass the trocar directly down into the cavity of the pelvis, at the

same point of incision used in the foregoing case. Give the body a good elevation, and aspirate. When the water is located in the limbs, the rubber bandage will be of great assistance in removing it.

To remove water from the hands and arms, first make an incision at the point of the elbow, passing the trocar underneath the skin, towards the shoulder, in different directions, and then in the same manner towards the hands. Afterwards apply bandage, wrapping from the shoulder to the elbow, then from the hand to the elbow. The pressure will force the water out of the incision at the elbow, when it will find its way along the rubber cover into the vessel ready to receive it.

To remove the water from the lower limbs, make an incision on either side of the knee, passing the trocar upwards; also, make incisions on either side of the ankles, directing the trocar towards the knee. Apply the bandage, commencing with the upper parts and working down.

The operation of drawing blood, in dropsy, is one of the greatest importance, as discoloration of the face and neck invariably are present. A large quantity of bloody water can be easily aspirated from the heart and vessels above, it being in a very liquid condition.

As a rule, in these cases, a second arterial injection is necessary, as is also a pumping out and reinjection of the cavities.

It is never necessary, under any circumstances, to open the body for the purpose of removing water. When the water is located in the pleural cavities, an incision should be made at the lower parts of the cavities, on both sides, between the seventh and eighth ribs, passing trocar immediately through the wall of the chest, when it will be in the sac of water. The water will pass out by gravitation, or may be aspirated. Then sew up the incision.

As this operation necessitates two incisions, it is not as desirable as that of passing the trocar, from the same point used in tapping the heart, down into each cavity, and aspirating. By operating at this point water can be removed from the heart sac. Very often water is located in different parts of the face. By passing a needle under the skin, at a point behind the ears, the water can be easily removed, and the mutilation will not be observable. In case of shipment, it would be wise to bandage dropsical cases, using the improved process given elsewhere.

JAUNDICE.

Jaundice is never strictly an individual disease. It is merely an effect or a symptom of disease. Thus, jaundice occurs in certain cases of all the hepatic affections, such as hepatitis, cirrhosis, phlebitis, cancer, etc. It occurs also in several general or constitutional diseases, namely, septicæmia, and puerperal, remittent, and relapsing fever.

The presence of bile pigment in the blood is due to the reabsorption of bile within the liver after its secretion. The biliverdin and the biliary salts are found within the liver; that is, they do not preëxist in the blood. The reabsorption of bile within the liver, in the great majority of cases, is due to obstruction to its passage into the intestine. It may proceed from other causes. Yellowness of the conjunctiva and skin takes place after a certain amount of bile has been reabsorbed. The discoloration of the surface depends mainly on the presence of the bile pigment in the transuded liquid which infiltrates the tissues.

TREATMENT.

There is no method of embalming that will remove the discoloration peculiar to jaundice. It will depend on

circumstances with regard to other conditions of the body, as to how difficult its preservation will be. In all cases give the body a thorough arterial and cavity treatment, always tapping the heart.

RHEUMATISM.

The great majority of cases of acute rheumatism ultimately end in recovery, the proportion of death as the immediate result of an attack being only four per cent. On the other hand, a large number of persons suffer from remote effects of the disease, many of which are not only distressing, but likely to lead to death. Of the immediately fatal cases, the larger proportion are associated with, if not actually due to, acute diseases of the respiratory organs. The fatal cases which present cardiac diseases, especially acute pericarditis, are scarcely less numerous. Altogether, it may be said that from one half to three fourths of all cases of death during acute rheumatism are referable to acute cardiac and pulmonary diseases, either separately or combined. It is doubtful whether acute rheumatism ever proves fatal ; that is, whether any patient dies from excessive pain, sweating, and consequent exhaustion. Hyperpyrexia is the most common cause of death, next to pulmonary and cardiac complications. In a small number of cases, acute alcoholism and other complications, mentioned elsewhere, lead to fatal termination. A most common effect is valvular diseases of the heart, which, in the majority of cases, are referable to acute endocarditis occurring as a complication of rheumatism. It is impossible to estimate the number of diseases of the lungs, vessels, brain, kidneys and other organs, which, in their turn, are caused by such heart diseases. The vessels suffer directly from the effects of rheumatism, and when.

in addition, the remote effects of pneumonia and pleurisy and the other less common complications of rheumatism are considered, the ultimate changes are very extensive.

Some of the complications in rheumatism are inflammation of the heart and pericardium, hyperæmia, and inflammation of the lungs, trachea, and larynx, inflammation of the various serous membranes, various nervous affections, such as meningitis and mental derangement, erythema, nodisum, and scarlatina, albumiuria, hyperpyrexia, hemorrhage, and lastly venous or intercurrent conditions. Cardiac complications are by far the most frequent, being present in no fewer than fifty per cent. of all cases. Inflammation of the heart and pericardium are fully described under their appropriate headings.

TREATMENT.

The treatment of these cases is indicated by the complicating diseases from which the patient dies. It is necessary to know the disease to understand the morbid anatomy. If the case is one of cardiac disease, or disease of the respiratory organs, the treatment should be the same as that given under these several heads.

TUMORS.

By a tumor is meant a more or less circumscribed mass growing in some tissue or organ of the body, and dependent on a morbid excess of, or deviation from, the normal nutrition of the part. Tumors are of many varieties, and may be found in any portion of the body. Cystic tumors of the ovary, which sometimes attain an enormous magnitude, are the kind that most requires our attention. They vary in size from a very small affair to a tumor

weighing many pounds. As they grow, their walls sometimes become very thick and firm, and often of great toughness. The contents may be thin and slightly colored, or, thick and of a dark color ; sometimes, of a yellowish hue. The quantity will vary from pints to many gallons. Encysted tumors, containing hair and fatty matter, will be met with occasionally. The fatty matter may be in a somewhat fluid condition.

TREATMENT.

Introduce the trocar into the abdomen at a point immediately below the navel, passing it downwards and inwards into the tumor. Attach aspirator and draw off the contents. It may be necessary to move the trocar in different directions inside the tumor, as there may be divisions or cells which will have to be broken in order to reach the liquid substance. Always inject fluid into the mass after aspirating.

When the tumor is on the surface of the body, it should be pierced with the trocar and liquid contents removed if there be any. It should then be injected with fluid.

There is no necessity of removing tumors from the cavity of the abdomen if they are treated in this way and injected with a first class fluid. In other respects, the treatment of such cases is similar to that of ordinary cases.

CANCER.

Cancers are internal or external, soft or hard. The surface of the external cancer may be entirely covered with skin, or it may be open and in a sloughing condition, emitting a very offensive odor. When located on the face, the features may be more or less destroyed.

TREATMENT.

If cancers are internal, or covered with an unbroken skin, they should be treated with the trocar; that is, they should be emptied of their contents and fluid pumped into the tumor. If they are external, and the skin is broken and in a sloughing condition, wash the surface with hot water and apply hardening compound. If sloughing has resulted in the destruction of the features, apply hardening compound to destroy the odor and absorb the moisture, leaving it remain for an hour or two, then cleanse the surface and build up with plaster of Paris, coloring with pencil tints. Treat the arteries and cavities in the usual manner.

SYPHILIS.

This is a specific, contagious disease—communicable by contact of the poison with a breach of the surface, or by hereditary transmission.

Morbid Anatomy.—Syphilis is characterized by a period of incubation, and (except in cases of inheritance) by certain changes in the seat of contagion, and in the proximate lymphatic glands. These are followed by eruptions on the skin and mucous membrane, and sometimes by lesions of the deeper tissues and viscera. Frequently burrowing abscesses, involving much tissue, are found in the peritoneum, groins, neck, and other parts of the body. Septicæmia may be the cause of death. The visceral organs may become a putrid mass. The sources of contagion are very numerous. Wherever the poison comes in contact with a broken surface, it may be absorbed and general infection follow.

Instances of syphilis being conveyed quite independently of sexual relations are very common. The disease

may be spread by kissing, contagious syphilitic lesions being quite common around the lips and in the mouth. Medical men not infrequently contract it by examining or operating on syphilitic cases.

TREATMENT.

In the handling of these cases, the care of one's hands is of the greatest importance. Before touching the body, thoroughly rub the hands, and under the finger-nails, with hand protector. Gloves should be worn as much as possible. The arterial injection should be made with the greatest care; in fact, should only be made when it cannot be avoided. The injection by the needle process is less dangerous to the operator, and is advised in these cases. Tap the heart, removing all the blood possible, which should be handled with the greatest caution. Fill the cavities with as much fluid as they will receive. Sponge the body thoroughly with a good disinfecting fluid, and apply hardening compound to all sores on its surface.

CONDITION AND TREATMENT OF MOTHER AND FŒTUS

The condition of the child and surrounding tissues will depend largely upon the cause of death, at what time during pregnancy it occurred, and whether the child died several days previous or at the same time.

Morbid Anatomy.— If death has occurred early in pregnancy, the morbid changes will not be very great, nor will the case give much trouble. But if at the full period, and the child has been dead for some days, the morbid changes will likely be considerable. There may be a putrefying mass of soft tissue, surrounded by a putrid fluid

filled with the putrefactive bacteria. If the child dies at the same time, only the liquor amnii (water) may be present.

TREATMENT.

Make an incision about two inches below the umbilicus or navel, on the median line. Pass the trocar into the womb allowing gases to escape. Move point of trocar to the lower part of the womb and attach aspirator; then remove all the liquid matter possible, which, as a rule, is considerable. Then inject fluid into the child and surround it with fluid; fill the womb with all it will take. After injecting arteries and treating the other cavities, remove the fluid from the womb, and inject fresh fluid.

CHAPTER XXVI.

DEATH FROM ACCIDENTAL CAUSES.

DROWNED CASES.

It will depend upon the length of time that the body has been in the water, and the condition of the body before drowning, as to how difficult it will be to preserve it.

TREATMENT.

Treat cases which have been in the water twenty-four hours or less, as follows:

Cover the face and hands immediately, so as to exclude air and light. Inject arteries and cavities thoroughly. Remove all the blood possible; also, empty the lungs and stomach of the water contained in them, which may be easily accomplished by placing the body face downward, elevating the lower parts, and pressing in the region of the stomach and lungs. A drawing out of the tongue at times will facilitate the operation. Keep face and hands covered with a bleaching fluid for several hours.

TREATMENT OF A "FLOATER."

When the body has been in the water sufficiently long to cause it to bloat, or, when it is in the condition known as a "floater," the following treatment will leave it in a state in which it may be placed in any kind of a casket,

and a funeral service at home or church is possible, without causing any inconvenience whatever to any person present:

Remove the water from the stomach and lungs as above directed. Insert long trocar into the cavities, allowing the gases to escape, and thoroughly fill the cavities with fluid. Insert needle at various parts of the face and body, immediately under the skin, passing it around to every possible point, when the gases will escape. The opening should be made with the point of the needle pointing downward, as gases rise, and are more easily extracted from the body than if the instrument were reversed. After removing gases, inject fluid wherever gases existed. Several gallons of fluid may be injected in this way, which will have the effect of arresting putrefaction of the surface and parts underneath.

If there is time to give (take it if possible), in addition to following the treatment prescribed above, success beyond a doubt will be the result. Take of Champion Hardening Compound about fifteen pounds. Mix with about twenty-five pounds of sawdust. Place a layer of a few inches in the bottom of a box, place the body upon it and cover with the remainder of the mixture, allowing a layer to intervene between the air and the body. In twenty-four hours the body will be in a satisfactory condition for the funeral.

The peculiar discoloration existing in a floater cannot be removed by any process known to science, but the deodorizing, disinfecting, and hardening of the body is a just source of gratification to the friends and relatives of the deceased, whose great wish is to give the unfortunate one the benefit of the church service. Of course, to produce a natural appearance of such bodies is out of the question and should not be expected.

LIGHTNING AND ELECTRICITY.

Death produced from these causes may show, in a post-mortem examination, an entirely different condition in different bodies. Some may exhibit no lesion whatever, the manner of death in these instances being shock to the brain and general nervous system. On the other hand the electricity may, in its passage through the body, produce a number of mechanical effects. Wounds like those inflicted by a blunt stabbing instrument may mark the point of entry and departure. Bones have been broken, internal viscera torn, and arteries and veins ruptured. Rigor mortis is not apparent as a rule, and the blood remains in a liquid condition. Decomposition commences very soon after death.

TREATMENT.

Remove the blood as quickly as possible by opening the femoral vein. Inject fluid into the femoral artery. An injection of fluid by the Champion Needle Process will be of great advantage. As the entire viscera becomes putrid in a very short time, the cavities should be thoroughly treated. Withdrawing the fluid and reinjecting them with fresh fluid, is also an advantage.

CASES OF MUTILATION.

As in Railroad and Other Accidents.

In death from railroad and other similar accidents great mutilation of the body often results. The extremities may be torn from the body; the trunk itself severed in twain; the head mashed, the brains oozing from the wounds; vessels torn, rendering the circulation of fluid through the arteries impossible.

TREATMENT.

The treatment of these cases will vary from the ordinary. The vessels, if possible, should be tied and injected; but, where it is impossible to do so, fluid should be freely injected into the subcutaneous tissues. Hardening compound should be used over the surface of the body and of all mutilated parts, and over and in the cavities. When the walls of the cavities are intact fluid should be injected freely into them and into all of the soft viscera. All gashes and cuts should be neatly sewed up and covered with hardening compound. Bruises and discolorations upon the face should be treated with the ice poultice. If the nose, lips and other parts of the face should be torn away they should be built up with plaster of Paris, and tinted sufficiently to produce the natural color as nearly as possible. All severed members should, if possible, be neatly sewed on.

If a body is torn to pieces in such a manner that coaptation of the parts is impossible, the following treatment may be used: take 15 pounds of hardening compound and 25 pounds of sawdust; thoroughly mix; cover the bottom of the box to a depth of two inches or more; place the parts therein, and cover with the remainder, allowing them to remain for twenty-four to forty-eight hours. This will thoroughly deodorize, harden and preserve the parts for shipment.

GUNSHOT WOUNDS.

If the wounds are in the head, they will interfere with the injection of the arteries, as the fluid will pass out through the ruptured vessels and escape through the openings made by the bullet. However, the injection should be made through some convenient artery, allowing the fluid

to ooze out through the wounds. With it, will pass out considerable blood which has escaped into the cavity. When the fluid which escapes commences to come clear, pack the opening tightly and inject about a quart of fluid. Allow the body to remain in an elevated position for several hours, in which time much of the fluid in the cavity of the cranium will have been absorbed by the tissues, or descended by gravitation to the lower parts. Remove the plugs from the wounds and force all the hardening compound you can possibly make use of into the cavity, backed up with some absorbent cotton. Mix a small quantity of plaster of Paris with water, putting into the mixture a little salt, filling the hole with the mixture. Putty made of a proper consistency, may be used instead. The part can be tinted, with flesh tints, to resemble the color of the surrounding parts. Treat cavities as usual.

ASPHYXIA.

Asphyxia is understood to mean that condition that results from the interruption or cessation of the function of respiration.

Causes.—Disease of, or injury to, the medulla oblongata, producing paralysis of there spiratary nerve centers; paralysis of the nerves or muscles of respiration; collapse or disease of the lungs; closing of the air passages by tumors or spasms of the glottis; by foreign bodies, suffocation, strangulation, hanging, drowning, etc.

Anatomical Characters.—Dr. Ferrier says: "The blood is of a dark color, owing to complete reduction of the hemoglobin, and the proportion of carbonic acid is greatly increased." The blood coagulates slowly or imperfectly, remaining fluid a long time, or forming only a few soft

coagula. The right side of the heart, large venous trunks, and the pulmonary artery, are distended with dark blood. Sometimes the left side and large arteries are full, but more frequently they are empty or contain only a small quantity of dark blood. The capillaries of the face and neck may be more or less congested. The lungs may be congested, but more frequently are pale and anæmic. Hypostasis is present. The viscera of the abdomen are usually congested.

TREATMENT.

In the treatment of asphyxia first ascertain whether death is present. When that is determined, place the body on the incline and remove the blood by tapping the heart. If discolorations remain in the face and neck apply the "ice poultice." Then inject the vascular system by the Champion Needle Process, or by raising an artery. Treat the cavities thoroughly and place the body on the level.

OPIUM OR MORPHINE POISONING.

In consequence of the extent to which opium and its preparations, including morphia, are used for the relief of pain, and the readiness with which the drug is procurable, poisoning by opium is of frequent occurrence; doubtless great numbers of infants perish every year in this country through the improper use of quack remedies containing opium.

Anatomical Characters.—The post mortem changes may be very slight. Generally the brain is congested, the puncta cruenta being especially marked; and the lungs and right side of the heart may exhibit an engorgement, as if from a modified asphyxia. This condition however is variable.

TREATMENT.

The body should be placed on the incline and the blood withdrawn by tapping the heart. The arterial system should then be injected with all the fluid that it will receive; also, fill the cavities very thoroughly. Inject fluid into the lungs through the trachea. Place the body on the level with the head only elevated. If trouble should supervene in the course of a few hours, such as the cellular and other tissues of the body softening and filling with gas, place the body high on the incline, and remove the gas by inserting the trocar from above downward into the subcutaneous tissue. Before removing the trocar inject fluid. Repeat this in all parts of the body, injecting fluid at each point. A gallon or more may be injected in this manner. Also, reinject arteries; pump out and reinject the cavities; then replace the body on the level. If the body is treated in this manner the results will be satisfactory.

DEATH CAUSED BY POISONOUS GASES.

POISONING BY CARBONIC ACID.

To inhale carbonic acid will produce fatal results sooner or later, owing to the degree of concentration. It accumulates in a very concentrated degree in pits, cellars, mines, old wells, lime kilns, fermenting vats, etc. When it is undiluted it is very rapidly fatal, as is seen when persons incautiously descend into an old well, or where miners enter a part of an old mine, or certain parts of a mine after an explosion. Death in these cases results very quickly.

Morbid Anatomy.—The morbid condition is similar to that of asphyxia, viz.: a general engorgement of the venous system. The blood is dark and fluid and easily

withdrawn. The hemoglobin is completely reduced. The heat of the body is retained a long time after death. Rigor mortis is well marked and lasts a long time.

TREATMENT.

Withdraw the blood by tapping the heart. Then fill the arteries and cavities in the usual manner.

POISONING BY CARBONIC OXIDE.

The deaths caused by charcoal fumes are due to carbonic oxide. Persons sleeping in close rooms in which the fumes escape from the stove or pipe are often asphyxiated. Death results quickly, as this gas is very poisonous.

Morbid Anatomy.—The specially characteristic morbid appearance is the bright cherry-red color of the blood and of the internal organs. The post-mortem discoloration is of a similar red tint. Also, the face of those poisoned with this agent retains a ruddy hue. Death ensues from asphyxia; therefore, a general engorgement of the venous system results; heat of the body is retained for a long time; the blood remains fluid; rigor mortis is marked.

TREATMENT.

Withdraw the blood by tapping the right auricle of the heart and inject the arterial system and cavities in the usual manner.

POISONING BY COAL GAS.

Death caused by coal gas often occurs by accident. Persons not in the habit of burning gas for illuminating purposes leave the gas cocks open on account of not knowing how to turn them off properly. Also, the gas is turned on in a close room for the purpose of committing suicide.

Morbid Anatomy.—On opening the body the smell of gas is often very marked. The blood is of a dark color, which readily coagulates, causing congestion of the face

and neck. The lung tissue is of a bright color; also, there is more or less froth in the air passages.

TREATMENT.

To remove the congestion in the face and neck the blood should be withdrawn, or the ice and salt should be applied. Inject the arterial circulation thoroughly. Also, fill the cavities with fluid.

PART FOURTH.

SANITATION AND DISINFECTION.

CHAPTER XXVII.

INFECTION.

(After Sternberg.)

CHANNELS OF INFECTION.

We have abundant evidence that an accidental infection, through an open wound or abrasion of the skin, is the common mode of infection in tetanus, erysipelas, hospital gangrene, and the "traumatic infectious diseases" generally. Other infectious diseases may be transmitted in the same way. We have also satisfactory evidence that tuberculosis may be transmitted to man by the accidental inoculation of an open wound.

The question whether infection may occur through the unbroken skin, has been studied by several bacteriologists, and an affirmative result obtained.

Infection may also occur through the mucous membrane of the respiratory organs. This has been demonstrated by several bacteriologists, and especially by the experiments of Buchner, who mixed dried anthrax spores with lycopodium powder or pulverized charcoal, and caused mice and guinea pigs to respire an atmosphere containing this powder in suspension. In a series of sixty-six experiments, fifty animals died of anthrax (splenic fever), nine of pneumonia, and seven survived. That infection did not occur through the mucous membrane of the alimentary canal, was proved by comparative experiments in which animals were fed with double the quantity of spores used in the inhalation experiments. Out of

thirty-five animals fed in this way, but few contracted anthrax.

That infection occurred through the lungs, was also demonstrated by the microscopical examinations of sections and by culture experiments, which showed that the lungs were extensively invaded, while in many cases the spleen contained no bacilli. That man may be infected by anthrax, by way of the respiratory organs, seems to be well established.

SUSCEPTIBILITY AND IMMUNITY.

No questions in general biology are more interesting or more important, from a practical point of view, than those which relate to the susceptibility of certain species of bacteria, and the immunity, natural or acquired, from such pathogenic action which is possessed by other animals. It has long been known that certain infectious diseases, now demonstrated to be of bacterial origin, prevail only, or principally, among animals of a single species. Thus, typhoid fever, cholera, and relapsing fever are diseases of man, and the lower animals do not suffer from them when they are prevailing as an epidemic. On the other hand,

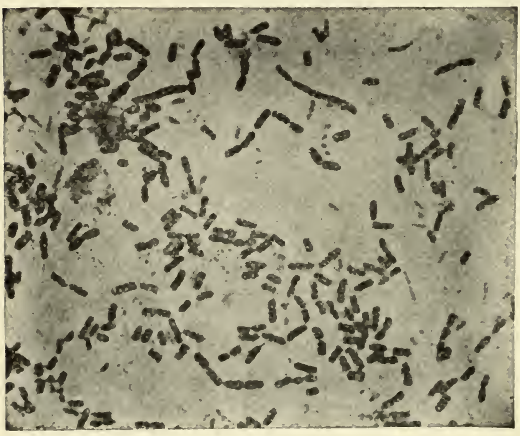

Fig. 31.

Bacillus Cadaveris, smear preparation from liver of yellow fever cadaver, kept 48 hours in an anticeptic wrapping, X 1000. From photomicrograph (Sternberg).

man has a natural immunity from many of the infectious diseases of the lower animals.

Exceptional susceptibility or immunity may be, to some extent, a family characteristic, or one of race. Thus, the negro race is decidedly less subject to yellow fever than the white race, and this disease is more fatal to the fair-skinned races of the north of Europe, than among the Latin races living in the tropical region. On the other hand, smallpox appears to be exceptionally fatal among negroes and dark-skinned races generally.

In the infectious diseases of man, involving the system generally, a single attack commonly confers immunity from subsequent attacks. This is true of eruptive fevers, typhoid fever, yellow fever, mumps, whooping cough, and, to some extent at least, of syphilis. But it seems not to be the case in epidemic influenza (la grippe), in croupous pneumonia, or in Asiatic cholera, in which diseases second attacks not infrequently occur.

In localized infectious diseases, such as diphtheria, erysipelas, and gonorrhœa, one attack is not protective. Croupous pneumonia should perhaps be grouped with diphtheria and erysipelas, as local infections with constitutional symptoms resulting from the absorption of tonic products. But typhoid fever, mumps and whooping cough, in which one attack gives immunity, are also localized infectious diseases.

We are therefore able to group infectious diseases into two classes, in one of which there is general infection followed by immunity; and in the other a local infection without subsequent immunity. Indeed, in the eruptive fevers and specific, febrile, infectious diseases generally, the immunity following an attack is not absolute.

Second attacks of smallpox, scarlet fever, and yellow fever, occur occasionally, although a large majority of those

who suffer an attack of one of these diseases, have an immunity for life. On the other hand, in the diseases mentioned, in which one attack is not generally recognized as protecting from future attacks, it is probable that a certain degree of immunity, of limited duration perhaps, is acquired.

In localized infection, as in gonorrhœa or erysipelas, the invaded tissues appear, after a time, to acquire a certain tolerance to the pathogenic action of the invading parasite, and no doubt recovery from these diseases would in many cases, after a time, occur without medical assistance.

In diphtheria, cholera and epidemic influenza, second attacks do not often occur during the same epidemic, and there is reason to believe that a recent attack affords a certain degree of immunity. That immunity may result from a comparatively mild attack, as well as from a severe one, is a matter of common observation in cases of smallpox, scarlet fever, yellow fever, etc. Since the discovery of Jenner, we have in vaccination a simple method of producing immunity in the first mentioned disease.

CHAPTER XXVIII.

HISTORY OF BACTERIOLOGY.

(AFTER ABBOTT.)

Antony Van Leeuwenhoeck, in the year 1675, gave birth to the study of bacteriology, by observations he then made with his primitive microscope. Though it is during the past twenty years that the research in this line has received its greatest impulse, yet it was developing for at least two centuries. Its relations to hygiene and preventive medicine are of the most important nature.

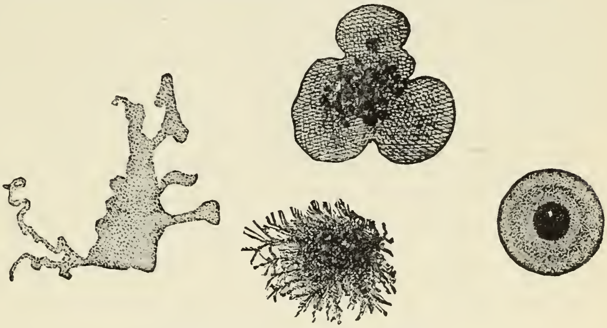

Fig. 32.—Colonies of Bacteria.

Indeed, modern hygiene owes much of its value to a more intimate acquaintance with the biological activities of the micro-organisms. Also, our knowledge in regard to infectious diseases has been developed to the present position. Though the contributions of the last few years have done more to place bacteriology on the footing of a science, yet, during the earlier years of its development, many were the observations made, which formed the groundwork for a great deal of that which has followed.

Leeuwenhoeck was born in Holland in 1632. He was not considered liberally educated, as he had been apprenticed in his early years to a linen draper. While an

apprentice he learned the art of lens grinding, which enabled him to perfect a lens by which he could see much smaller objects than had hitherto been seen by the microscopes in use at that time. He was still following in the trade of a linen draper in Amsterdam at the time he made his discoveries. In 1675 he published the fact that he could detect living, motile animalcules of the very smallest dimensions—smaller than anything that had heretofore been seen—by means of his perfected lens. Being encouraged by this discovery he continued his work to the examination of various other materials for the presence of animal life, as he considered it, in its most minute form. In sea water, in well water, in his own diarrhœal stools, and in the intestinal canal of frogs and birds, he found organisms whose morphology differed, and which also differed in the peculiarity of movement which some were seen to possess.

In 1683 he examined the tartar scraped from between the teeth, and discovered a form of micro-organism upon which he laid great stress. He made a contribution of this discovery, which was presented to the Royal Society of London on September 14, 1683. The particular importance of this paper is because of the careful description given of an objective nature of the bodies seen by him, and for the illustrations which accompany it. There is little room for doubt that Leeuwenhoeck, with his primitive lens, had seen the bodies that we now recognize as bacteria. With the greatest astonishment he saw distributed everywhere through the material which he was examining animalcules of the most microscopic dimensions, which moved themselves about in a remarkably energetic way. This was followed shortly after by other equally important observations.

Speculation is absent throughout all of his work. His contributions are of a purely objective nature.

Plenciz, a Vienna physician, a believer in the work of Leeuwenhoeck, in 1762, made observations confirming the discoveries of the latter. He claimed a casual relation between the micro-organisms discovered and described by Leeunwenhoeck and all infectious diseases. He also claimed that infection could be nothing else than a living substance, and endeavored to explain the variations in the incubation period of the different infectious diseases on these grounds. He believed that the micro-organisms were capable of multiplying in the living body, and spoke of the possibility of its transmission through the air. He taught that each disease had its special germ, on the principle that only one kind of grain can grow from a given cereal.

Fig. 33.

Bacillus Tuberculosus, from a culture on glicerin-agar, X 1000. From a photomicrograph by Fränkel and Pfeiffer.

He found innumerable minute animalculæ in all decomposing matter, and was so thoroughly convinced of their etiological relation to the process, that he formulated the law, that decomposition can only take place when the decomposable material becomes coated with a layer of the organisms, and can proceed only when they increase and multiply.

The arguments of Plenciz were looked upon by some, as the imaginations from an unbalanced mind, and by others as entirely absurd.

Ozanam, in 1820, expressed himself on the subject as follows: "Many authors have written concerning the animal nature of the contagion of infectious diseases; many have indeed assumed it to be developed from animal substances and that it is itself animal and possesses the

property of life. I shall not waste time in efforts to refute these absurd hypotheses."

Many other medical men expressed similar opinions during this time, doubting the possibility of animal life existing in these micro-organisms.

The true relation of the lower organisms to infectious diseases was established scientifically, just before the middle of the present century, by the coincidence of a number of important discoveries. The cause of putrefaction in beer and the souring of wine, by Pasteur; the finding of rod-shaped organisms in the blood of all the animals that die of splenic fever (anthrax), by Pollender and Davaine; and the knowledge upon the parasitic nature of certain diseases of plants, arouse attention to the old question of animal contagion. Henle was the first to logically teach this doctrine of infection. The principal point that had occupied the attention of scientific men from time to time, up to the middle of this century, was the origin of these micro-organisms. One side claimed that they descended from creatures that existed previously, of the same kind. Needham, in 1749, held firmly to the doctrine of spontaneous generation as a result of vegetation changes in the substances in which they were found. He experimented with a grain of barley placed in a watch crystal of water, carefully covered, allowed it to germinate, and claimed that the bacteria that were present were the result of changes in the barley grain itself, incidental to its germination.

Spallanzani, in 1769, drew attention to the laxity of Needham's methods, and demonstrated that if infusions of decomposable vegetable matter were placed in flasks, hermetically sealed, then allowed to remain in boiling water for some time, no living organisms nor decomposition would appear in the infusion so treated. Objection

was raised to this method, on the grounds that the high temperature to which the infusion had been raised had so altered them, and the air around them, that the favorable conditions no longer existed to spontaneous generation. To meet this objection, Spallanzani took one of his flasks that had been boiled and tapped it gently against some hard object until he produced a very minute crack; organisms and decomposition appeared, as in infusions that were not so treated. Very little advance was made from this time until 1836, when Schulze called attention to the subject by his investigations. He allowed air, deprived of its organisms by passing through a strong acid or alkaline solution, to gain access to boiled infusions, and no living organisms nor decomposition appeared in the infusions.

Schwann, in 1837, robbed air of its organisms by passing it through highly heated tubes into his infusions.

Schröder and Von Dusch interposed cotton-wool between the infusion and the air, robbing the air of its microorganisms as it passed into the infusions by filtration.

Hoffman, in 1860, and Pasteur, in 1861, demonstrated that all that was necessary was to draw out the neck of the flask into a fine tube, bend it down along the side of the flask and then bend it up again a few inches from its extremity, and leave the mouth open, to prevent the access of bacteria to the infusion in the flask, as when boiled the drop of water of condensation in the lower angle will avert the organisms and none can enter the flask. Doubters still existed and some still held out for "spontaneous generation," wanting further proof, when, in 1876–77, Prof. Tyndall made his investigations upon the floating matter in the air, and demonstrated that these organisms, being present in decomposing fluids, were always to be explained either by the preëxistence of similar living forms in the infusion, or upon the walls of the vessel containing it, or, by

the infusion having been exposed to air which had not been deprived of its organisms.

FORMS OF BACTERIA.

In form, bacteria are unicellular and are seen to exist as spherical, rod or spindle-shaped bodies developed from preëxisting cells of same character, not spontaneous. They are now classified into three groups with their subdivisions, the outline of which is a sphere, a rod, or a spiral.

To these three divisions are given the names:

Cocci, or Micro-cocci — spherical forms.

Bacilli — oval or rod forms.

Spirilli — twisted like a corkscrew.

The duration and vitality of spores of different organisms varies from weeks to years. In all cases it exceeds that of the mature state, which is limited to that of hours. Whereas drying or drowning rapidly disposes of many active microbes, they produce much less effect on spores. The importance of spore formation depends upon the fact that spores are far more persistent and more resistant to mimical influence, than the microbes from which they are derived; this, combined with their minuteness, facilitates their diffusion, and the dissemination of the diseases to which they give rise.

Fig. 34.
Pus containing streptococci, X 800 (Flügge).

AN ANTISEPTIC.

An antiseptic is a body which, by its presence, prevents the growth of bacteria without of necessity killing them. A body may be an antiseptic without possessing disinfecting properties to any very high degree, but a disinfectant is always an antiseptic as well.

CHAPTER XXIX.

RECENT METHODS OF GIVING IMMUNITY TO CERTAIN DISEASES.

SMALLPOX.

The same obscurity hangs over the cause of smallpox as over those of many other diseases of the zymotic class, such as of measles and scarlatina. While, however, the causes of these two latter diseases seem still active, there is every probability that of smallpox has subsided, and that this disease has now no other source than human contagion. The poisonous material of smallpox is given out from the mucous and cutaneous surfaces of the patient, especially from the lungs and skin, and from the exhalations, the secretions, the excretions, the matter in the vessels and pustules, and the scabs. These all contain the noxious germs of the disease, which may attach themselves to bedclothes, body cloths, and especially to woolen, cotton and felten articles. Such stuffs retain the specific poison for a very long but undetermined period, just as the hat, cap and coat worn in the dissecting room retains the peculiar odor of the place for a very long period. It is not yet determined at what period the poison is generated by the patient's person, whether during the primary fever or not till after the eruption has appeared; but it is probably secreted during the primary fever. Generally it may be stated that the poison is most powerful when it is most manifest to the sense of smell; that the dried

crusts of the pustules or scabs possess a contagious quality and retain it for a very long time, and it is unsafe for a susceptible person to be in the same room or in the same house pervaded by the disease. The dead body of a variolated person is equally infectious, and students who have been near it when brought into the dissecting room have in consequence fallen ill of the disease. The infecting distance must therefore be many yards around the patient's room. The fact of the contagious nature of smallpox has been fully demonstrated by the one general practice of inoculation, and the poison by this operation has been proved to exist in the serum, in the pus, and in the crusts of the smallpox pustule. There is no law more singular and unexpected in the whole range of morbid poisons than that the introduction of the variolous poison by means of the cutaneous tissue should produce an infinitely milder disease than when the same poison is absorbed by a mucous tissue. The causes which predispose to smallpox, or increase the susceptibility of infection, are:

(1) A very early age.

(2) Not having been vaccinated.

(3) Not having had the disease before.

Such are called unprotected persons.

(4) Peculiarity of constitution, *e. g.*, the negro and dark races.

(5) Fear of infection.

(6) Epidemic influences.

It is very gratifying to know that of recent years the prevalence and mortality of smallpox is greatly less than it was wont to be.

The prognosis of the natural smallpox is always most grave. The danger may be measured to a certain degree, by:

(1) The quantity and confluence of the eruption.

(2) The state of the circulating fluids.

(3) The presence and nature of the respiratory organs and nervous centers.

(4) Age and habit of the patient.

(5) Nature of the epidemic constitution which may prevail.

According to some authorities the greatest number die on the eighth day, others say the eleventh, and others between the eleventh and eighteenth.

VACCINATION.

Thousands of physicians concur in confirming the belief in the prophylactic and modifying influence of vaccination in smallpox. The conclusions now arrived at regarding vaccination may be summed up in the following statements:

(1) That, vaccination is a safe and efficient protection, and confers an immunity upon those who mingle with smallpox cases.

(2) That, there is no important difference between the protecting power of varioloid and vaccinia during childhood, under circumstances of ordinary exposure. With regard to severe exposure, there are no facts to determine one way or the other.

(3) That, there are no facts to determine the comparative protective power of varioli and vaccination in adults under ordinary exposure, but there is abundant proof of the enormous amount of protection afforded by vaccination.

(4) That, adults severely exposed relying in what is ordinarily termed vaccination will probably take smallpox, though of a modified nature, in a greater ratio than those having previously had smallpox by inoculation.

(5) That, if vaccination has been thorough and efficient, it is extremely probable that the liability to smallpox under severe exposure is not greater than after inoculation.

(6) That, those statements are entirely without foundation which speak of smallpox after inoculation as a risk hardly exceeding a possibility and never to be taken into account, while smallpox after vaccination is represented as a thing of daily and constant occurrence.

(7) That, the representation that the protection afforded by vaccination gradually wears out till at length it leaves the system as liable to attack as though protection had never been imparted, is not only unproved but is opposed to important facts and in all probability will turn out to be unfounded.

(8) That, there is, however, a great proclivity to smallpox, whether natural or after vaccination, between the ages of fifteen and twenty-five.

(9) That, the mortality from smallpox has decreased since vaccination was introduced.

DIPHTHERIA.

Diphtheria is an acute infectious disease, produced by a diphtheritic bacillus. It is characterized by local manifestations in the throat and larynx, by a false membrane, sometimes extending into the posterior nares, sometimes throughout the larynx, trachea and bronchi. There is no doubt of the disease being constitutional; that is, the poison is absorbed by the blood and carried to all the tissues of the body. As the disease has become more prevalent, the great object of the physician has been to stay its ravages in some manner.

ANTITOXIN.

Therefore, the bacteriologists have studied the disease with a view not only to lessen the gravity and introduce a specific treatment, but to give immunity against the disease, by a similar process to that of vaccination as a

preventive to smallpox. Bacteriologists in America and Europe have given this matter thorough study, and, as a result, have introduced to the profession a material now known as antitoxin, which counteracts the toxic effects of the diphtheritic poison.

Dr. Behring (Berliner Klinische Wochenschrift, 1894, No. 36), has ably summed up the blood serum theraputic method as follows:

First.—It is an antitoxic method by which we endeavor to combat this infectious disease. The specific antitoxin, which is the active agent, has until now been found in quantities sufficient to be available for human medication, only in the blood of immunized animals.

Second.—It is a principle of the blood serum therapy that large doses are never injurious, but on the contrary can be only beneficial.

Third.—The blood serum therapy is a specific therapy. The blood antitoxin is immunizing and curative only for the infection.

Fourth.—Under the influence of a specific toxin there is produced a specific antitoxin from the albumen of the living cell. Whilst this is going on there is a disturbance of the regulating mechanism of the general organism. The febrile and other symptoms of the toxic infection are an expression of the effort of the living organism to render the foreign poison innocuous. In animal experiments we can so arrange things that the living organism succeeds. In immunizing animals we can render the absorption of large quantities of the poison harmless by increasing the toxin production.

Fifth.—If we examine the fluids of the body after recovery from an artificial or natural toxic infection, we find not only that the toxin is compensated by the antitoxin, but that there is a surplus of the latter. This sur-

plus is the reason why a larger quantity of the toxin must now be introduced, in order to produce an intoxication. And this surplus can be employed to help other individuals to overcome the same intoxication.

Sixth.— Since the antitoxin is a soluble body, it is not impossible that it may eventually be produced outside the living body, or even compounded synthetically.

TETANUS, OR LOCK-JAW.

Our knowledge regarding the pathology of tetanus until recently has been very limited. The symptoms which characterize this affection were referable to an abnormal influence of the nerve centers, which control the action of the voluntary muscles. But since the progress in bacteriology our knowledge has been much increased in this respect. Tetanus has been found to be produced by a specific bacillus, known as the bacillus tetani.

Nicolaier, in 1884, produced tetanus in mice and rabbits, by introducing garden earth beneath their skin, and showed that the disease might be transmitted to other animals by inocculation with pus or cultures in blood serum, containing the tetanus bacillus.

Sternberg, in 1880, produced tetanus in a rabbit by injecting beneath its skin a little mud from the street gutters in New Orleans.

Tetanus bacillus appears to be a widely distributed microörganism in superficial layers of the soil in temperate and especially in tropical regions.

TETANUS ANTITOXIN,

If used in its fresh state, has been found to produce immunity from the disease, and is said to be curative by some that have experimented with this antitoxin.

CHAPTER XXX.

DISINFECTION AND ITS EFFECTS.

(AFTER SYKES.)

Disinfection, strictly speaking, implies dealing with infection, but, in its popular and wider sense, it embraces purification in all its applications. The burning of volatile substances, the libations of liquids and the sprinkling of powdery compounds on a large scale, are now recognized as feeble or futile substitutes for physical and chemical means of destroying infection.

Stable and unstable, organic and inorganic, substances are dealt with either by physical or chemical means, in the process of cleansing and purification. We apply physical means to movable matters, without regard to their preservation, by removing by road or water, and disposing of them upon the surface, or by burial, or by burning, according to the proximity of dwellings, and other conditions. Such objects as are not removable are washed, scraped, etc., the resultant refuse being taken away or destroyed in some way. There are other methods which with the above should be adopted in preference to the more temporary measures resorted to by the use of chemicals for the purpose of treating organic decomposing matters. It is this process of chemical treatment of decomposable refuse that popularly and fallaciously passes under the name of disinfection. This is fostered by the popular habit of styling many and varied substances disinfectants.

Decomposition and putrefaction are the result of micro-organic life in the beneficent work of resolving organic substances into their inocuous elements. During this transmutation malodorous gases are given off, and deodorants, whether by overpowering or by absorbing, or by breaking up the gases, produce little or no effect upon the decomposing substances. Odors are the tell-tales of filth, and simply washing them is a fallacious remedy. To prevent the odoriferous stage being reached, preservation against decomposition is practiced by the use of antiseptics, but their application is limited to substances and places where removal or destruction are undesirable, temporarily or permanently, and they require careful and discriminate employment to be of value in preventing the effects of access of micro-organisms.

Incidentally it may be mentioned that food is preserved by physical means, as cold, exclusion or filtration of air, and by chemical means, as smoking, salting, and the use of other chemical substances. Their interest here only lies in the fact that preservatives are allied closely to antiseptics in their effects on organic substances.

The only antiseptics that should be used are those which not only inhibit microscopic life, but are directly fatal to it as germicides. This implies the actual destruction of the germs, and the measure of this power requires more exact verification than the mere prevention of decomposition, which antiseptics may be held to infer, although many germicides, in a diluted or weakened state, become or act as antiseptics.

Disinfection, in a more restricted and accurate sense, implies the destruction of the infection produced by the specific micro-organisms of disease, as distinguished from pollution by micro-organic life generally. Although it must be admitted that our knowledge as yet scarcely

enables us to draw any sharp line between pathogenic and nonpathogenic organisms, and especially in reference to the causation of septic diseases, yet, in the recognized infectious diseases, whether the specific organisms have been found or not, disinfection is applied to the destruction of the specific infection. The only means of judging whether this destruction is effectually accomplished is by actual experiment upon cultivations of known microbes, a method that has largely displaced the earliest rough process of measurement by the retardation of decomposition. Thus, restricted to the destruction of specific infection, the process of disinfection admits of the application of various measures by mechanical means, and by physical and chemical agencies. Some of the physical means are cleansing, exposure to air, heat (as burning), steam, dry heat, etc. Moist heat (steam) is by far the most efficacious. Dry heat is distributed too unequally, so that it does not penetrate bulky articles.

Of the vast number of chemical agents vaunted as disinfectants, very few possess any true germicidal power. A certain number are more or less antiseptic; a large number are merely deodorant, and many are more or less inert.

The efficacy of a germicide depends upon the quantity in which it is used and the length of time during which it is allowed to act. A true disinfectant may be used in such small quantity, or may be diluted so largely by the medium to be disinfected, that its action may be reduced to infinitesimal proportions, and in actual practice this is what usually occurs.

Koch's experiments upon anthrax spores, with a large number of chemical agents in solution, showed that they were killed within one day's exposure only by the following: chlorin bromine (2 per cent.), iodine, mercuric chlorid (1 per cent.), potassic permanganate (5 per cent.),

osmic acid (1 per cent.). Oil of turpentine (pure) required five days' exposure; hydrochloric acid (2 per cent.), ten days; ferric chlorid (5 per cent.), six days; chlorid of lime (5 per cent.), five days; and formic acid, four days. As disinfection under ordinary conditions must be completed rather in minutes than in hours, the latter class is out of the question. Of the former, osmic acid is not fitted for practical use, and the quantity of permanganate of potash required would be excessive. There remain, therefore, mercuric chlorid and the halogens. Mercuric chlorid has been shown to be the most powerful disinfectant in solution known at present.

Koch found that one part per million checked the growth of anthrax bacilli, and three parts arrested it, and that one part per thousand killed the spores of anthrax in ten minutes. Klein's experiments were in the main confirmatory, but required stronger solutions to produce the same results. It is these differences of results, due to varying conditions, in experiments with disinfectants, that render it difficult to estimate their true value. Carbolic acid has lost its high reputation in the hands of Koch. He found that it required a one per cent. solution of phenol more than one day to kill spores: hence, a ten per cent. solution one day to destroy the infection of tuberculous sputum. The halogens — iodine, bromine and chlorin — are used in the form of gases in a similar manner to nitrous and sulphurous acid gases.

Abbott says, "In the destruction of bacteria by means of chemical substances, there occurs most probably a definite chemical reaction; that is to say, the characteristics of both the bacteria and the agent employed in their destruction are lost in the production of a third body, the result of their combination. It is impossible to say with absolute certainty, as yet, that this is the case, but the

evidence that is rapidly accruing from the more recent studies upon disinfectants and their mode of action, point strongly to the accuracy of this belief. This reaction, in which the typical structure of both bodies concerned is lost, takes place between the agent employed for disinfection and the protoplasm of the bacteria. For example, in the reaction that is seen to take place between the salts of mercury and albuminous bodies, there results a third compound, which has neither the characteristics of mercury nor of albumin, but partakes of the peculiarities of both; it is a combination of albumin and mercury known by the indefinite term albuminate of mercury. Some such reaction as this occurs when the soluble salts of mercury are brought in contact with bacteria. He says, further, that this view has recently been strengthened by the experiments of Geppert, in which the reaction was caused to take place between the spores of the anthrax bacillus and a solution of mercuric chlorid, the result being the apparent destruction of the living properties of the spores by the formation of this third compound. Still, it did not of necessity imply the complete death of the protoplasm of the spores, for if by proper means the combination of mercury with their protoplasm was broken up, many of the spores returned from apparent death to life, with their previous disease-producing and cultural peculiarities. Geppert employed a solution of ammonium sulphid for the purpose of destroying the combination of spore-protoplasm and mercury. The mercury was precipitated from the protoplasm as an insoluble sulphid, and the protoplasm of the spores returned to its original condition.

"These and other similar experiments have given a new impulse to the study of disinfectants, and in the light shed by them many of our previously formed ideas concerning the action of disinfecting agents must be modified. We

must use a disinfectant sufficiently strong and enough of it to destroy the bacteria in the material that we wish to disinfect.

"For example, the disinfection of certain kinds of material containing pathogenic organisms, such as sputa, excrete or blood, by means of corrosive sublimate, is questionable. The amount of sublimate may be used up and rendered inactive as a disinfectant by the presence of the albuminous bodies without having any effect upon the bacteria which may be in the matter. Although, as a matter of fact, *I believe that if a solution strong enough and a sufficient quantity be used in contact with the bacteria for a long enough time, it will insure their destruction.*"

CHAPTER XXXI.

ANTISEPTIC AND GERMICIDAL VALUE OF VARIOUS SALTS.

(AFTER STERNBERG.)

ARRANGED ALPHABETICALLY.

Alum:—Antiseptic in the proportion of 1:222.

Aluminum Acetate:—According to De la Croix, this salt is an antiseptic in the proportion of 1:6310.—(*Kühne.*)

Aluminum Chlorid:—Antiseptic in the proportion of 1:714.—(*Miquel.*)

Ammonium Carbonate:—When present in the proportion of 1:125, it restrains the development of typhoid bacilli, and in five hours it kills them. The cholera spirillum is killed, in the same time, by 1:77.—(*Kitasato.*)

Ammonium Chlorid:—Antiseptic in the proportion of 1:9.—(*Miquel.*)

Ammonium Fluosilicate:—The bacilli of anthrax and typhoid fever fail to grow in nutrient gelatin containing 1:1000, and a two per cent. solution kills anthrax spores in from one to three quarters of an hour.—(*Koch.*)

Ammonium Sulphate:—Antiseptic in the proportion of 1:4.—(*Miquel.*)

Barium Chlorid:—Antiseptic in the proportion of 1:10. —(*Miquel.*)

Calcium Chlorid:—Antiseptic in the proportion of 1:25. —(*Miquel.*)

Calcium Hypochlorite:—This is a powerful germicidal agent and has great value as a practical disinfectant. Good chlorid of lime contains from twenty-five to thirty per cent. of available chlorin as hypochlorite. The experiments made by the Committee on Disinfectants of the American Public Health Association, in 1885, showed that a solution, containing 0.25 per cent. of chlorin as hypochlorite, is an effective germicide, even when allowed to act only for one or two minutes. In Bolton's experiments, a solution of chlorid of lime of 1:2000 (available chlorin 0.015) destroyed the typhoid bacillus and the cholera spirillum in two hours. For the destruction of anthrax spores a one per cent. solution (available chlorin 0.015) was required. Nissen found that the typhoid bacillus and the cholera spirillum are destroyed with certainty, in five minutes, by a solution containing 0.12 per cent.

Chloral Hydrate:—Antiseptic in the proportion of 1:107. —(*Miquel.*)

Cupri Chlorid:—Antiseptic in the proportion of 1:1428.—(*Miquel.*)

Cupri Sulphate:—Antiseptic in the proportion of 1:111 —(*Miquel.*) Kills the cholera spirillum in the proportion of 1:3000 in ten minutes. A solution of 1:20 kills the typhoid bacillus in ten minutes. In Bolton's experiments made for the Committee on Disinfectants of the American Public Health Association, the following results were obtained: Bacillus of typhoid fever were killed by solution, 1:200; cholera spirillum, 1:500; and bacillus pyocyanus, 1:200.

Ferri Chlorid:—A five per cent. solution failed, in two days, to destroy anthrax spores, but succeeded in destroying them in five days.—(*Koch.*)

Ferrous Sulphate:—In the writer's experiments in 1883, a solution of twenty per cent. failed to destroy micrococci and putrefactive bacteria. In more recent experiments, a solution of ten per cent. failed to kill pus cocci, but was fatal to micrococcus tetragenus, after two hours' exposure. The antiseptic power of ferrous sulphate is placed by Miquel at 1:90.

Gold Chlorid:—Antiseptic in the proportion of 1:4000. —(*Miquel.*)

Lead Chlorid:—Antiseptic in the proportion of 1:500. —(*Miquel.*)

Lead Nitrate:—Antiseptic in the proportion of 1:11.—(*Miquel.*)

Manganese Protochlorid:—A solution of 1:1000 destroys anthrax spores in a few minutes.—(*Koch.*) According to Yersin, a solution of 1:1000 kills the tubercle bacillus in one minute. This is a valuable agent as an antiseptic and germicide for general purposes of disinfection, in the proportion of 1:500 or 1:1000.

Mercuric Cyanide:—The development of bacillus anthracis in culture solution is prevented by the presence of cyanide of mercury in the proportion of 1:250000.

Mercuric Iodide:—The antiseptic value of this salt is placed by Miquel at 1:40000.

Morphia Hydrochlorate:—Antiseptic in the proportion of 1:400.—(*Miquel.*)

Platinum Bichlorid:—Antiseptic in the proportion of 1:3333.—(*Miquel.*)

Potassium Acetate:—A saturate solution of this salt failed to kill anthrax spores in ten days.—(*Koch.*)

Potassium Arsenite:—Miquel places its antiseptic value at 1:8.

Potassium Bichromate:— Efficient as an antiseptic in the proportion of 1:909.—(*Miquel.*)

Potassium Bromide:—The bacillus of typhoid fever and the cholera spirillum failed to grow in culture solutions containing 9:10.6 per cent. and were killed in five hours by one per cent.—(*Kitasato.*)

Potassium Chromate:—A five per cent. solution failed to kill anthrax spores in five days.—(*Koch.*)

Potassium Cyanide:—Antiseptic in the proportion of 1:909.—(*Miquel.*)

Potassium Iodide:—A five per cent. solution does not destroy anthrax spores in eighty days.—(*Koch.*) Putrefactive bacteria in broken-down beef infusion are not destroyed by two hours' exposure in a twenty per cent. solution.—(*Sternberg.*) It is antiseptic in the proportion of 1:7.—(*Miquel.*)

Potassium Permanganate:—Antiseptic, according to Miquel, in the proportion of 1:285.

Quinine Hydrochlorate:—Antiseptic in the proportion of 1:9000.—(*Ceci.*) Quinine dissolved with hydrochloric acid in a one per cent. solution destroys anthrax spores in ten days.

Quinine Sulphate:—Prevents development of various micrococci and bacilli in the proportion of 1:800.

Silver Nitrate:—Miquel places this next to mercuric chlorid as an efficient antiseptic. in the proportion of 1:12500. Behring also places it next to bichlorid as an antiseptic and germicide, and claims it is even superior to this salt in aluminous fluids.

Silver Chlorid:—A solution of chlorid of silver in hyposulphite of soda is, as an antiseptic, much less effective than nitrate of silver.

Sodium Borate:—Antiseptic in the proportion of 1:14. —(*Miquel.*)

Sodium Carbonate:—A solution of 2.2 per cent. restrains the growth of typhoid bacillus, and one of 2.47 per cent. that of the cholera spirillum.—(*Kitasato.*)

Sodium Chlorid:—Antiseptic in the proportion of 1:6.—(*Miquel.*)

Sodium Hyposulphite:—Antiseptic in the proportion of 1:3.—(*Miquel.*)

Sodium Sulphite:—The result of the writer's experiments with a saturated solution of this salt, was entirely negative.

Tin Chlorid:—A one per cent. solution, acting for two hours, destroyed the bacteria in putrefying bouillon.—(*Abbott.*)

Zinc Chlorid:—In the writer's experiments, 1:200 destroyed micrococcus Pasteuri in two hours. Antiseptic in the proportion of 1:526.—(*Miquel.*)

Zinc Sulphate:—A twenty per cent. solution has failed to destroy micrococci from the pus of an abcess in two hours.

CHAPTER XXXII.

PRACTICAL DIRECTIONS FOR DISINFECTION.

(AFTER STERNBERG.)

After years of experimenting and investigation, we have arrived at the conclusion that the following are the best disinfectants known to science:

The Best Agents for Destroying Spore Containing Infectious Material Are:

Complete destruction by fire.

Strong steam pressure, 105° C. (221°F.) for half an hour.

Boiling in saturated salt solution one pound to a gallon.

Chlorid of lime, an eight per cent. solution.

Bichlorid solution of 1:500.

For Destruction of Micro-organisms Not Containing Spores:

Boiling in water for half an hour.

Dry heat, 110°C. (230°F.) for two or three hours.

Chlorid of lime, a four per cent. solution.

Chlorinated soda, a ten per cent. solution.

Bichlorid of mercury, a solution of 1:2000.

Carbolic acid, a ten per cent. solution.

Zinc chlorid, a ten per cent. solution.

Sulphur dioxide, a fumigation of at least twelve hours in the presence of moisture.

For Excrementitious Matter in Sick Room:

Chlorid of lime in solution, four per cent.

Carbolic acid in solution, five per cent.

Sulphate of copper in solution, five per cent.

In Privy Vaults:

Mercuric chlorid in solution, 1:500.

Carbolic acid in solution, five per cent.

For Disinfection and Deodorization of Surface Matter in Water Closets:

Chlorid of lime, in powder.

For Clothing, Bedding, etc.:

Boiling for at least one hour.

Immersion in a four per cent. solution of carbolic acid for four hours.

For Outer Garments of Wool or Silk:

A strong current of steam for fifteen minutes.

Exposure to a dry heat at a temperature of 110°C. (230°F.) for three hours.

For Mattresses, Blankets, and All Bedding Soiled by the Discharge of the Sick:

Destruction by fire.

Exposure to super-heated steam, 105° C. (221° F.) for half an hour — mattresses to have the covers freely opened.

Immersion in boiling water for one hour.

For Furniture, etc.:

Washing several times with a solution of carbolic acid, five per cent.

For the Person:

The hands and body may be washed with a solution of chlorinated soda diluted with nine parts of water, 1:10.

Carbolic acid, a ten per cent. solution.

Mercuric chlorid, 1:1000.

For the Dead:

Envelop the body in a sheet thoroughly saturated with a four per cent. solution of chlorid of lime.

Mercuric bichlorid solution, 1:500.

Carbolic acid solution, five per cent.

For Sick Rooms:

Wash all surfaces with bichlorid of mercury in solution, 1:500.

Carbolic acid in solution, ten per cent.

Fumigate with sulphur dioxide for twelve hours, burning at least three pounds of sulphur to every thousand cubic feet of air in the room.

Wash all surfaces with one of the above solutions and afterwards with soap and boiling water; then ventilate freely by opening doors and windows.

A More Desirable Method would be the following: Take for an ordinary sized room containing about 1000 cubic feet of air, two pounds of chlorid of lime. Place in an earthen dish. Mix six ounces of muriatic acid with a quart of water, and pour the mixture on the lime. Keep the room tightly closed for four hours, then ventilate by opening doors and windows. Furniture may be washed as in direction given above.

For Rags:

Rags used for wiping infectious sores should be burned.

For Disinfection of the Hands:

Remove all visible dirt from the finger nails. Brush the hands thoroughly with hot water and soap. Immerse the hands for ten minutes in a bichlorid solution, seven grains to the pint. Rub thoroughly with a clean towel.

PART FIFTH.

GENERAL MISCELLANY.

CHAPTER XXXIII.

RESUSCITATION.

Definition.—The recovery from suspended animation or apparent death. In these conditions of course all signs of circulation and respiration have disappeared, but usually the failure of one function has preceded the other. For the purpose of treatment we may regard as

(a) Syncope, those cases when the lips and mucous membrane are found pale and exsanguine; and as

(b) Asphyxia, those when they are dark colored.

TREATMENT FOR SYNCOPE.

Place the patient horizontally on his left side, with the pelvis and feet raised. Nelaton has urged complete inversion of the body, but by its interference with the free action of the diaphragm this method may be injurious. The windows of the room should be opened; the face fanned and a little cold water may be sprinkled on the forehead, smelling salts being held to the nostrils. If natural breathing has not returned, begin

HOWARD'S METHOD OF ARTIFICIAL RESPIRATION:

Position of Patient.—Face upwards; a hard roll beneath thorax, with shoulders slightly declining over it. Head and neck bent back to the utmost. Hands on top of the head. Strip clothing from waist and neck.

Position of Operator.—Kneel astride of patient's hips; place your hands upon his chest so that the ball of each thumb and little finger rest upon the inner margin of the free border of the costal cartilages, the tip of each thumb

near or upon the ensiform cartilage, the fingers dipping into the corresponding intercostal spaces. Fix your elbows firmly, making them one with your hips.

Action of Operator.—Pressing upwards and inwards towards the diaphragm, use your knees as a pivot, and throw your weight slowly forwards two or three seconds, until your face almost touches that of your patient, ending with a sharp push which helps to jerk you back to your erect kneeling posture. Rest three seconds, then repeat this movement as before, continuing it at the rate of seven to ten times a minute, taking the utmost care in the occurrence of a natural gasp, gently to aid and deepen it into a longer breath, until respiration becomes natural. The method is said to keep the passage through the larynx free without the aid of any assistance or any contrivance for the purpose, and is recommended for that reason. Keep up the temperature of the body by hot blankets or hot bottles. Ether or nitrate of amyl may be held to the nostrils. A little brandy and hot water, eau de cologne and water, wine or other stimulant, as sulphuric ether or sal volatile, should be given with care, that none of it enter the trachea. If swallowing be impracticable, inject warm fluids into the rectum.

TREATMENT FOR ASPHYXIA.

Asphyxia from Breathing Noxious Gases.—The body should be brought into fresh air and artificial respiration at once commenced, whilst an assistant should blow into the mouth and nostrils three or four times; apply hot blankets and hot water bottles.

Asphyxia from Mechanical Obstructions of the Air Passages.—The cause of obstruction must be removed, if possible. By adopting the inverted position of Howard's method, coins or fruit stones may thus dislodge themselves. In the absence of forceps, a button hook or the handle of a

tablespoon may be useful, especially in the removal of a lump of hard food.

Asphyxia from Poisons or Anæsthetics.—In the asphyxia of advancing coma from narcotics, the breathing may stop from the failure of the medulla and respiratory nerves to act. In this case artificial respiration by simply compressing the chest at intervals of five seconds may suffice, but very often there is the mechanical obstruction in the larynx to be considered. If raising the chin and throwing the head back does not effect a free passage of air, Howard's or some other method of artificial respiration should be commenced.

TREATMENT FOR RESTORING A DROWNED PERSON.

Asphyxia from Drowning.—In asphyxia from immersion in the water there are two serious complications, namely, first, the presence of water and mud in the air passages; and secondly, the depressing effect of cold. With the view of more effectually removing the water from the air tubes, Howard gives the following rules:

Position of Patient.—Face downwards; a hard roll of clothing underneath the stomach making that the highest part, the mouth the lowest. Forehead resting on forearm or wrist. Keeping mouth from ground.

Position and Action of Operator.—Place left hand well spread upon the base of thorax to the left of spine, the right hand upon the spine, a little below the left and over the lower part of the stomach. Throw upon them with a forward motion all the weight and force the age and sex of the patient will justify, ending this pressure of two or three seconds by a sharp push, which helps you back again into the upright position. Repeat this two or three times, according to the duration of the immersion and then resort to the method described in the treatment of syncope.

DIRECTIONS FOR RESTORING THE APPARENTLY DEAD.

If from drowning or from other suffocation or narcotic poisoning: Send immediately for medical assistance, blankets and dry clothing, but proceed to treat the patient instantly, securing as much pure air as possible.

The points to be aimed at are, first and immediately, the restoration of breathing; and secondly, after breathing is restored, the promotion of warmth and circulation.

The efforts to save life must be persevered in until the arrival of medical assistance, or until the pulse and breathing have ceased for at least an hour.

TREATMENT FOR LIGHTNING STROKES.

A stroke of lightning is not necessarily fatal in spite of the popular notion to the contrary. Prof. Oliver Lodge warns the public against this belief. He says that lightning stops the vital organs, but rarely destroys them. If respiration can be artificially maintained sufficiently long, there is a fair chance that the heart will resume its suspended action, and that the victim will recover. Consequently, a person struck by lightning should never be pronounced dead, until Howard's method of resuscitation, explained above, has been practiced upon the apparent corpse for two or three hours. Dr. d'Arsonval, in France, has practiced this method with success, and strenuously urges its adoption. Experience in this country also justifies the practice. This is a matter of great importance, for, although comparatively few people are killed by lightning in this country, it seems probable enough that the number could be still further reduced by practicing artificial respiration.

TREATMENT FOR RESTORING NATURAL BREATHING.

RULE 1.—**To Maintain a Free Entrance of Air Into the Windpipe:**—Cleanse the mouth and nostrils; open

the mouth; draw forward the patient's tongue and keep it forward. An elastic band over the tongue and under the chin will answer this purpose. Remove all tight clothing from about the chest and neck.

Rule 2.—**To Adjust the Patient's Position:**—Place the patient on his back on a flat surface, incline a little from the feet upwards, raise and support the head and shoulders on a small firm cushion or folded article of dress placed under the shoulders.

Rule 3.—**To Imitate the Movements of Breathing:**—Grasp the patient's arms just above the elbows and draw the arms steadily and gradually upward, until they meet above the head, and keep the arms in that position for two seconds. (This is for the purpose of drawing air into the lungs.) Then turn down the patient's arms, and press them gently and firmly for two seconds against the sides of the chest. (This is with the object of pressing air out of the lungs. Pressure on the breastbone will aid this.) Repeat these measures alternately, deliberately and perseveringly, fifteen times a minute, until a spontaneous effort to respire is perceived, immediately upon which cease to imitate the movements of breathing and proceed to induce circulation and warmth. Should a warm bath be procurable the body may be placed in it up to the neck, continuing to imitate the movements of breathing. Raise the body in twenty seconds to a sitting posture, and dash cold water against the chest and face and pass ammonia under the nose. The patient should not be kept in the warm bath longer than five or six minutes.

Rule 4.—**To Excite Inspiration:**—During the employment of the above method, excite the nostrils with snuff or smelling salts, or tickle the throat with a feather; rub the chest and face briskly, and dash cold and hot water alternately on them.

TREATMENT AFTER NATURAL BREATHING HAS BEEN RESTORED.

RULE 1.—**To Induce Circulation and Warmth:**—Wrap the patient in dry blankets and commence rubbing the limbs upwards firmly and energetically. Promote the warmth of the body by the application of hot flannels, bottles or bladders of hot water, hot bricks, etc., to the pit of the stomach, armpits, between the thighs, and at the soles of the feet. Warm clothing can generally be had from the bystanders. When swallowing has returned, a teaspoonful of warm water, small quantities of wine, warm brandy and water or coffee should be given. Sleep should be encouraged. During the reaction large mustard poultices applied to the chest will relieve the distressed breathing.

RULE 2.—**If from Intense Cold:**—Rub the body with some ice or cold water. Restore warmth by slow degrees. It is dangerous to apply heat too early.

RULE 3.—**If from Intoxication:**—Lay the individual on his side on a bed, with his head raised. The patient should be induced to vomit.

RULE 4.—**If from Apoplexy or Sunstroke:**—Cold should be applied to the head which should be kept raised. Tight clothing should be removed and stimulants cautiously used.

STIMULANTS AND FOOD.

How soon should alcoholic stimulants be given? Certainly not till natural respiration has been induced, and, in cases of narcotic poisoning, not until consciousness has been restored. If on the return of consciousness the patient is in pain or faint, the inhalation of a few drops of ether or smelling salts is advised. In their absence a few drops of brandy may be given. Hot tea and coffee should be the first refreshment swallowed, and in general it should not be pressed upon the patient as vomiting is more exhausting than waiting a few hours for food.

CHAPTER XXXIV.

MISCELLANEOUS INFORMATION.

POST-MORTEM WOUNDS.

Post-mortem wounds are poisoned wounds resulting from the inoculation of a virus derived from the dead bodies of men or lower animals. The poison is present in its most virulent form in fresh bodies, and diminished in intensity as decomposition advances. It is most marked when inoculation occurs in handling cases of septic peritonitis or pleurisy, pyæmia, septicæmia, puerperal fever, diffuse cellulitis, erysipelas or spreading gangrene. The poison only acts by direct inoculation, usually occurring through a scratch or wound made accidentally while operating on the body. Any partly healed raw surface, or the cracks in chapped hands, or the little fissures at the margin of the nails, serve equally well as points of inoculation.

Prevention.—Before operating upon the dead body the hands should be very carefully examined. If the cuticle be denuded at any point on the hands or fingers, use rubber gloves, finger cots, or the Champion Hand Protector. The latter is rubbed over the hands, under and around the nails very carefully, to prevent the absorption of the poison. While operating be very careful not to wound with the different instruments used in the operation. If such an accident should occur, suck the wound thoroughly and wash out with a fluid that contains bichlorid of mercury, and cover with Champion Hand Protector. Gas from the body does not cause blood poisoning when inhaled, but it may cause a kind of septic fever.

If a wound is received and inoculation results, in from twelve to twenty-four hours the point of inoculation becomes more or less red and irritated. It may remain in this state for another day, when a brawny swelling of a dusky red color forms around it, and extends rapidly in all directions, but principally along the line of the lymphatics. There is intense burning pain and severe constitutional disturbances, high temperature and total loss of appetite, which may be followed by "spreading gangrene;" or. the lymphatic glands may become swollen and painful and abscesses form at the elbow and axilla. Septicæmia or pyæmia may follow.

If any of the above symptoms result, send for the family physician at once and be placed under proper treatment.

To Bandage a Body for Shipment.

Encasing the body in bandages is not necessary, not even in cases for shipment, unless the case is one of dropsy, when it should be done as follows: Use a roll of unbleached muslin bandage or cheese cloth from three to four inches wide, commencing at the neck and including every part of the body to the tips of the fingers and toes, in the same manner as the surgeon applies a bandage to a broken limb, except it is not necessary to reverse it, to make it conform to the shape of the body. After one course of bandage has been neatly applied, cover it all over with a coat of silicate of soda by means of a two or three inch varnish brush. This should be followed by another bandage and coat of silicate of soda, finally covering the whole with a bandage neatly applied. This encasement will be impervious to air and become as hard as glass itself in a few minutes. The face should be left exposed to view.

GLOSSARY.

A

Abdomen.—The largest cavity of the body, in which are situated the intestines, stomach, etc.

Abductor.—A muscle which moves certain parts by separating them from the axis of the body.

Absorbents.—The vessels and portions of the body which concur in the exercise of absorption.

Acetabulum.—The socket for holding the head of the thigh bone.

Addison's disease.—Disease of the suprarenal capsules.

Adductor.—A muscle which draws one part of the body toward another.

Adipocere.—A substance formed by a spontaneous change in the dead tissues of animals.

Adipose.—That which relates to fat; fatty.

Agminate.—To aggregate or cluster together; said of lymphatic glands forming patches in the small intestine (Peyer's patches), as distinguished from the solitary glands.

Albumen (*albus*, white).—A thick, viscid substance, which forms a constituent part of both animal fluids and solids, which exists nearly pure in the white of egg.

Albuminuria.—Albumen in the urine; Bright's disease.

Alimentary.—Pertaining to food.

Alimentary canal.—The great duct or intestine by which aliments or food are conveyed through the body, and the useless parts evacuated.

Alkali.—A substance having the following properties: solubility in water; power of neutralizing acids and forming salts with them; combining with fats to form soaps; corrosive action on animal and vegetable tissues; changing the tint of many vegetable coloring matters.

Alkaline.—Pertaining to, or having the properties of, alkali.

Alkalis (fixed).—Potash, soda, and lithia.

Amyloid.—Resembling starch.

Anæmic.—Bloodless.

Anæsthesia.—Loss of sensation.

Anæsthetic.—A substance that destroys the feeling of pain.

Anasarca.—Effusion of fluid into subcutaneous and other cellular tissues

Anastomosis.—Communication between two vessels.

Anatomy.—The art of dissecting, or artificially separating the different parts of any organized body, to discover their situation, structure and economy.

Aneurism.—A tumor connected with an artery containing blood.

Animalcula.—A small animal.

Antiseptic.—A substance that prevents or retards putrefaction.

Antitoxin.—The serum of the blood of a horse, that has been inoculated with diphtheria material, used as subcutaneous injection for the cure of diphtheria.

Anthrax.—See CARBUNCLE.

Aorta.—The main artery of the body from which all others (except pulmonary) originate (p. 56).

Aponeurosis.—A white, shining membrane, composed of interlacing fibers, sometimes continuous with the muscular fibers, and differing from a tendon only in having a flat form.

Aponeurotic.—Pertaining to aponeurosis.

Apoplexy.—Loss of consciousness, sensation and voluntary motion, due to a morbid state of the brain.

Appendage.—That which is attached to something as a necessary part.

Appendicitis.—Inflammation of the appendix vermiformis.

Appendix vermiformis.—A worm-like process, about the size of a goose quill, which hangs from the cæcum, whose functions are unknown.

Approximation.—Approaching; being near.

Appurtenance.—An adjunct, or appendage.

Aqueous humor.—A limpid fluid filling the space between the crystalline lens and the cornea, and divided into two chambers by the iris.

Arachnoid.—A membrane like a spider's web covering the brain.

Areolæ.—The interstices between the fibers composing organs.

Areolar.—Pertaining to areolæ; filled with interstices or areolæ.

Areolar tissue.—A loose mixture of the white fibrous, and yellow elastic tissues; the loose tissue connecting the skin with subjacent parts.

Arterialization.—The transformation of venous blood and chyle into arterial blood by respiration.

Arteriole (dim. of *arteria*).—A small artery.

Artery.—A vessel of the body which contains pure blood.

Articulate.—To unite by means of a joint.

Articulation.—The joining or juncture of the bones of a skeleton.

Arytenoid cartilages.—Two cartilages of the larynx which by approximation diminish the aperture of the glottis.

Ascites.—Dropsy of the peritoneum; abdominal dropsy.

Aseptic.—Free from the living germs of disease, fermentation and putrefaction.

Asphyxia.—Suspended animation caused by the non-conversion of the venous into arterial blood in the lungs.

Assimilation.—The process by which nutriment is changed into, and becomes a part of, a living tissue.

Asthma.—Difficult breathing.

Atlas.—The first cervical vertebra, supporting the weight of the head.

Atrophy.—Defective nutrition.

Atrophy of the liver.—Diminution in size.

Auricles (*auris*, ear).—Two upper cavities of the heart.

Auricular.—That which belongs to the ear.

Auscultation.—The act of listening.

Axilla.—The cavity beneath the juncture of the arm with the shoulder.

Axis.—Second vertebra.

Axis.—A right line which passes through the center of a body.

B

Bacilli (pl. of *bacillus*).—Microscopical, vegetable organisms, having the form of very slender, straight filaments, consisting of a single cell; rod-shaped bacteria.

Bacteria.—The lowest known forms of life; can be seen only by the microscope.

Basilar.—That which belongs to certain parts which seem to serve as bases to others, as the sacrum and sphenoid bones.

Basilic.—See Basilar.

Biceps.—A muscle with two heads; a name given to a muscle of the upper part of the arm and one of the thigh.

Bifurcation.—Division of a trunk into two branches.

Bile.—A fluid secreted by the liver.

Biliary.—Pertaining to the bile.

Biliverdin (green).—The coloring matter of the bile.

Blood.—The fluid which circulates through the arteries and veins, carrying nutriment to all parts of the body (pp. 54 and 144).

Bone.—A firm, hard substance composing the skeleton.

Brain, anæmia of.—Deficient quantity of blood in the brain.

Brain, aneurism of.—Disease of the arteries of the brain.

Brain, carcinoma of.—Cancer of the brain.

Brain, congestion of.—An increased quantity of blood in the brain.

Bright's disease.—Disease of the kidneys, in which the tissues may fill more or less with water; albuminuria.

Bronchi.—The two branches of the windpipe.

Bronchial tubes.—Subdivisions of bronchi.

Bronchioles.—The last and most minute subdivisions of the bronchi.

Bronchitis.—An inflammation of the lining membrane of the bronchial tubes.

Bulla.—A portion of the cuticle detached from the skin by the interposition of a transparent, watery fluid.

Burrow.—To excavate a hole in.

Bursa (a purse).—A small sac near a joint containing fluid.

C

Cæcum.—The commencement of the large intestine, forming a closed tube before the insertion of the small intestine.

Calcareous.—Containing, or consisting of, lime.

Calculus (pl. *calculi*).—Any hard, solid concretion formed in any part of the body, especially in the excretory canals.

Caliber.—The diameter of a body.

Canaliculus.—A small channel.

Cancer, or Carcinoma.—A roundish, hard, unequal, scirrhous tumor, which usually ulcerates, is very painful, and generally fatal.

Capillaries.—The smallest of the blood vessels, connecting the arteries and veins.

Carbonic acid.—A deadly gas given off by the lungs and by fire.

Carbonic oxide.—A gaseous compound of one equivalent of carbon and one of oxgen. It is fatal to animal life, extinguishes combustion, and burns with a pale blue flame, forming carbonic acid.

Carbuncle, or Anthrax.—A specific local inflammation of the subcutaneous areolar tissue, rapidly leading to sloughing of the deeper parts, followed by destruction of the skin, the whole of the dead tissue finally separating in the form of a slough.

Carcinoma.—See CANCER.

Carotids (*karos*, lethargy).—Arteries of the neck.

Carpus.—The wrist.

Cartilage.—Gristle; an elastic, animal tissue, similar to bone, but softer.

Cartilaginous.—Pertaining to, consisting of, or resembling, cartilage.

Cartouch.—An elliptical oval on ancient Egyptian monuments, and in papyri, containing groups of characters giving the names and titles of the Pharaohs.

Catalepsy.—A disease of the nervous system, characterized by attacks of powerlessness, commonly with loss of consciousness, accompanied by a peculiar form of rigidity of the muscles, in which the extremities remain for a time in the position in which they are placed.

Cataleptic.—Relating to, or affected with, catalepsy.

Catarrh.—An inflammation, acute or chronic, of the mucous membrane of some organ.

Cauda equina (horse's tail).—The spinal marrow at its termination, about the second lumbar vertebra, gives off a number of nerves which, when unraveled, resemble a horse's tail.

Cellular.—Full of cells.

Cellulitis.—Inflammation of the cellular membrane.

Cephaline.—The base or root of the tongue.

Cerebellum (A little brain).—The small, back division of the brain.
Cerebro-spinal fever.—An inflammation of the covering membranes of the brain and spinal cord.
Cerebro-spinal meningitis.—An alarmingly fatal form of epidemic fever.
Cerebro-spinal system.—The part of the nervous system having its origin in the brain and spinal cord.
Cerebrum.—The larger division of the brain.
Cerecloth.—A cloth smeared with melted wax, or with some gummy or glutinous matter.
Cerumen.—The ear wax.
Cervical.—Relating to the neck.
Child-bed fever.—See PUERPERAL FEVER.
Cholera.—A disease characterized by vomiting and purging, as the essential symptoms, and also by griping and spasms in the legs and arms.
Cholera, Asiatic.—A malignant form of cholera.
Cholera infantum.—A fatal disease of childhood.
Cholera morbus.—The mild and common form of cholera.
Choroid coat.—Middle coat of the eye.
Choroid plexus.—Two membranous and vascular duplicatures of the pia mater, situated in the lateral ventricles of the brain.
Chyle.—A nutritive fluid, extracted by intestinal absorption from food which has been subjected to the action of the digestive organs.
Chyliferous.—Chyle-bearing.
Chyme.—Food as it passes into the small intestine after partial digestion in the stomach.
Circle of Willis.—The anastomosis which exists between the branches of the internal carotid and vertebral arteries at the base of the brain.
Circulatory system.—The heart and blood vessels.
Circumduction.—The moving of a limb around an imaginary axis so as to describe a conical form, the distal end moving in a circle, while the proximal end remains fixed.
Cirrhosis.—A yellow coloring fluid, sometimes secreted by the tissues, owing to a morbid process.
Cirrhotic.—Affected with, or having the character of, cirrhosis.
Coagulability.—Capacity of being coagulated.
Coagulation.—Change of a fluid to a curd-like state, by some kind of chemical action; a clotting of blood.
Coagulum (pl. *coagula*).—A soft mass formed in a coagulable liquid.
Coaptation.—To join or bring together.
Colitis.—Inflammation of the colon or large intestine; dysentery.
Collateral.—That which accompanies, or proceeds by the side of, another.
Colon.—That part of the large intestine which extends from the cæcum to the rectum.

Coma.—A profound state of sleep, from which it is extremely difficult to rouse the individual; stupor.

Comma bacillus.—A name applied by Koch to a rod-like bacteria with rounded ends, usually slightly curved like a comma, found in excreta and intestines of cholera patients; by other bacteriologists named spirrilum choleræ Asiaticæ.

Commissure.—A collection of transverse fibers connecting parts on each side of the brain and spinal marrow.

Condyle.—An articular eminence, round in one direction, flat in the other.

Congested.—Containing an unnatural accumulation of blood.

Conjunctiva.—The mucous membrane covering the external surface of the eye and inner surface of the lids.

Contagious.—Communicable by contact, by the breath, etc.

Contraction.—Act of contracting, or drawing together.

Convolutions.—Wave-like projections on the surface of the brain; turns made by the intestines.

Convulsion.—An unnatural violent and involuntary contraction of the muscular parts of the human body.

Cornea.—The transparent portion of the external coat of the eye.

Corniculum laryngis.—A small, very movable, cartilaginous tubercle, observed on the arytenoid cartilages.

Corpora striata (pl. of *corpus striatum*).—Pyriform eminences, which form part of the floor of the lateral ventricles of the brain.

Corpus.—A body.

Corpus callosum.—A white, medullary band perceived on separating the two hemispheres of the brain.

Corpuscles.—A little body; applied to the disks of the blood.

Corpus fimbriatum.—A narrow, white, tape-like band, situated immediately behind the chorid plexus.

Cranial.—Of, or pertainining to, the cranium, or skull.

Cranium.—The skull.

Cremation.—A burning of the body.

Crescentic-shaped.—Shaped like a crescent.

Crus.—Leg or horn.

Crus cerebri.—A peduncle of the brain.

Crystalline lens.—The lens of the eye, situated immediately behind the pupil.

Culture.—To cultivate; a term used in science to denote the cultivation of various forms of micro-organisms.

Cutaneous.—Pertaining to the skin.

Cuticle.—Outer layer of the skin.

Cutis.—Inner layer of the skin; derma, or true skin.

Cyst.—A closed pouch or sac containing fluid or soft matter.

D

Decomposition.—The separation of parts; decay.

Decussate.—To cross like an X.

Decussation.—Union in the shape of an X or cross.

Deglutition.—The art by which substances are passed from the mouth into the stomach, through the pharynx and esophagus.

Dejecta.—The discharge from the alimentary canal; excrement.

Dependent.—Lowest.

Derma.—True skin; inner layer of the skin.

Desiccate.—To become dry.

Desquamation (to scale off).—Separation of the epidermis, in the form of scales of a greater or less size.

Diabetes.—A disease characterized by great augmentation, and often manifest alteration in the secretion of urine, with excessive thirst and progressive emaciation.

Diaphragm.—The membranous muscle which separates the thoracic from the abdominal cavity.

Diffusion.—Dissemination, or spreading, as of a fluid through the vessels and tissues of the body.

Digestion.—The process by which the food is prepared for absorption into the circulation.

Diploe.—The areolar structure which separates the two tables of the skull from each other.

Diphtheria.—An epidemic disease in which the air passages, and especially the throat, become coated with a false membrane, produced by the solidification of an inflammatory exudation.

Discoloration, post-mortem.—Changes in the surface of the body, caused by diffusion of the blood into the tissues, formation of gases, putrefactive changes, etc.

Disinfection.—Any process by which the contagion of any given disease may be destroyed or rendered inert.

Disseminate.—To spread; diffuse.

Distal.—Outer end, or end farthest from center of body.

Diuretic.—Having the power to excite the secretion and discharge of urine.

Dorsal (*dorsum*).—The back.

Dorsum of tongue.—The upper surface of tongue.

Dropsy.—An unnatural collection of serous fluid in any cavity of the body or in the areolar tissues.

Duct.—A small tube.

Duodenum.—The upper part of the small intestine (p. 39).

Dura mater (*dura*, hard; *mater*, mother).—A fibrous, semitransparent membrane lining the cavity of the cranium and containing the spinal marrow.

Dysentery.—Inflammation of the mucous membrane of the large intestine.

E

Ecchymoma.—A livid, black or yellow spot, produced by blood effused into the areolar tissue from a contusion.

Ecchymosis.—See ECCHYMOMA.

Edematous.—Affected with œdema.

Effete.—Worn out; exhausted energy.

Effusion.—Escape of blood or any other fluid from its natural vessel into the areolar membrane, or into the cavities of the body.

Eliminate.—To expel.

Emaciation.—The condition of being lean; wasting or loss of flesh.

Embolism.—The arrest in the arteries or capillaries of a solid body that has been carried along in the course of circulation.

Embolus (pl. *emboli*).—A wedge or plug.

Emphysema.—A distention of a part by air or gas.

Empyæmia.—A collection of blood, pus, or other fluid, in some cavity of the body, especially that of the pleura.

Enamel.—The substance covering the crown of the teeth.

Endemic disease.—A disease peculiar to a people or nation.

Endocarditis.—Inflammation of the lining membrane of the heart.

Endocardium.—The membrane lining the interior of the heart.

Endometritis.—Inflammation of the lining membrane of the uterus.

Endosteum.—The membrane lining the interior of bones.

Enteritis.—Inflammation of the intestines.

Entero-colitis.—Inflammation of small intestine and colon.

Epidemic.—A disease affecting a great number of persons at once.

Epidermis.—Outer layer of the skin.

Epigastric region.—Above the stomach, or what is commonly known as the pit of the stomach.

Epiglottis.—The valve which prevents the entrance of food and drink into the larynx.

Epistaxis.—Bleeding from the nose.

Epithelioma.—Cancer of epithelium or skin.

Epithelium.—The thin layer of epidermis, covering parts deprived of derma, as the nipple, lips, etc.

Erosion.—A destruction of superficial tissue, as by friction, pressure, etc.

Erysipelas.—A febrile disease, accompanied with a diffused inflammation of the skin, which, starting usually from a simple point, spreads gradually over its surface.

Erythema.—Erysipelas.

Escharotic.—An agent that destroys tissue and produces a slough.

Esophagus.—The gullet.

Eviscerate.—To disembowel.

Excoriation.—A slight wound, which removes only the skin.

Excrement.—Everything which is evacuated from the body, such as the fecal matter, urine, etc.
Exudate.—Exudation; act of exuding; sweating.
Excrementitious.—Pertaining to excrement.
Excrete.—To throw off.
Excretion.—Excrement.
Excretory.—Having the quality of throwing off excrementitious matter.
Exhumation.—The disinterment of a corpse.
Exophthalmic.—Protrusion of the eyeball from the socket to such an extent that the lids will not close.
Exsanguine.—Deprived of blood; bloodless.
Extension.—The act of extending; a spreading.
Extravasation.—Escape of a fluid from the vessel containing it.
Extravasation of blood.—The escape of blood from the blood vessels into the surrounding tissues.
Extremity.—The end or termination; the limbs.
Exudation (to sweat).—The oozing of a material through the pores of a membrane.

F

Falx.—A membranous reflection, having the shape of a falx or scythe.
Falx cerebri.—The greatest process of the dura mater.
Fascia.—A bandage or fillit.
Fasciæ.—The aponeurotic expansion of muscles which bind parts together.
Fasiculus(pl. *fasiculi*).—A small bundle.
Fauces.—The posterior part of the mouth, terminated by the pharynx and larynx.
Febrile.—Pertaining to fever; indicating fever.
Feces.—Excrement.
Fiber.—A slender, thread-like element, as of any tissue.
Fibrin.—A complex, nitrogenous substance which appears in fresh blood, and is found in the chyle. It is elastic and generally of a thread-like structure, which is insoluble in water, but soft when exposed to air.
Fibrous tissue.—The connective tissue of different parts of the body.
Filament.—A separate fiber of a nerve, or other tissue.
Fistula.—A permanent, abnormal opening into the soft parts with a constant discharge.
Fistulous.—Relating to, or resembling, a fistula.
Flaccid.—Soft.
Flexion.—A bending.
Flexure.—A turn, bend, or fold.
"Floater."—A body which has remained in the water long enough to become bloated and rise to the surface.
Fœtus.—The young of any creature; the unborn child.

Follicles.—Small, glandular tubes; glands.

Fomites.—A term applied to substances which are supposed to retain contagious effluvia; as woolen goods, feathers, etc.

Foramen.—Any cavity pierced through and through.

Foramen magnum.—A large oval aperture or opening in the median line of the occipital bone.

Fossa.—A cavity of greater or less depth; a groove.

Frænum.—A bridle; name given to several membranous folds, which bridle and retain certain organs.

Fumigate.—To fill a circumscribed space with gas or vapor, with the intention of purifying the air.

Function.—The action, or mode of operation, peculiar to any organ.

Fusiform.—Spindle-shaped.

G

Gall bladder.—A conical-shaped, membranous sac, the reservoir of the bile.

Ganglion.—A knot-like enlargement in the course of a nerve; a collection of nerve cells.

Gangrene.—Privation of life or partial death of an organ; first step of mortification of living flesh.

Gastric.—Pertaining to the stomach.

Gastric juice.—A digestive fluid secreted by the peptic glands.

Gastritis.—A disease characterized by pyrexia, seated in the peritoneal or mucous coat of the stomach.

Gelatine (jelly).—A nutritious substance, semi-transparent, insipid and inodorous in character.

Germicide.—A disinfectant having the power to destroy all living disease germs, or bacteria.

Germs.—Microörganisms, especially of injurious kinds.

Gland.—A soft, globular organ in the human body, which secretes or excretes some substance peculiar to itself.

Glandular.—Having the appearance, form or texture of a gland.

Glenoid.—The cup-shaped cavity which receives the head of the humerus.

Glottis.—The opening between the pharynx and larnyx.

H

Halogens.—Substances which by combination with a metal form haloid salts.

Heart.—The chief organ of circulation.

Hematuria.—Voiding blood by the urine.

Hematemesis.—Vomiting of blood.

Hemiplegia.—Paralysis of one side of the body.

Hemoglobin.—Coloring matter of the blood.

Hemoptysis.—Spitting of blood; hemorrhage of the lungs.

Hemorrhage.—The escape of blood from any part of the circulation; bleeding.

Hepatization.—A solid and friable condition of the lung resembling the liver somewhat in its physical characters.
Hepatitis.—Inflammation of liver or its peritoneal covering.
Hernia.—See RUPTURE.
Hobnail liver.—Cirrhosis of the liver.
Homogeneous.—Consisting of similar parts, or of like nature.
Humid.—Moist, as a humid atmosphere.
Hybernate.—To winter; to pass the winter in close quarters, as birds or beasts.
Hydræmia.—A watery condition of the blood.
Hydro.—A prefix meaning watery.
Hydrogen.—The lightest gas known; one of the elements of water.
Hydro-thorax.—Dropsy in the chest.
Hypæmia.—A deficiency of blood in a part.
Hyperæmia.—An excess of blood in a part.
Hyperpyrexia.—Excessive pyrexia, or fever.
Hypertrophy.—Excessive growth of a part.
Hypodermically.—Consisting in the application of remedies under the skin.
Hypostasis.—Settling of blood into the dependent parts of the body.
Hypoglossal (under the tongue).—A nerve of the tongue.
Hypostatic.—Relating to hypostasis.

I

Icteric.—Pertaining to, or affected by, jaundice.
Ileac.—Pertaining to the ileum.
Ileum.—The third and longest division of the small intestine, extending from the jejunum to the cæcum.
Iliac.—Of or belonging to the ilium.
Ilium.—Upper part of the hip bone.
Immunity.—Freedom from danger of contagion.
Imputrescible.—Not subject to putrefaction.
Incubation.—The period that elapses between the introduction of a morbific principle into the animal economy and the invasion of the disease.
Infectious.—Communicable by infection; specially applied to diseases which are capable of being communicated from one to another, or which pervade certain places, attacking persons independent of any contact with those already sick.
Infiltrate.—To enter by penetrating the pores of a substance.
Inflammation.—A redness or swelling of any part or organ of the body, attended by heat, pain, and febrile symptoms.
Infusion.—The act or process of steeping any insoluble substance in water in order to extract its virtues; also, the liquid so obtained.
Inguinal.—Belonging or relating to the groin.

Inhibit.—To repress or restrain.

Inoculation.—An operation by which a disease may be artifically communicated, by introducing the virus of the particular disease into the economy by means of a puncture.

Inorganic.—Not having the organization of parts characteristic of living bodies; not possessing life.

Inosculate.—To anastomose, or unite.

Insertion.—The condition of being inserted.

Insertion of muscle.—Its more movable extremity.

Interstices.—Intervals between organs, or parts of organs.

Interosseous.—That which is situated between the bones.

Intestine.—Lower part of the alimentary canal, divided into small and large.

Intussusception.—A form of intestinal obstruction, in which one portion of the bowel passes into another portion.

Invagination.—Same as intussusception.

Involuntary muscle.—A muscle not under control of the will.

Irritability.—A susceptibility to the influence of natural or medical agents.

Irritant.—That which irritates or causes pain.

-itis.—A suffix used to indicate inflammation of an organ or tissue.

J

Jaundice.—A disease giving a yellowness to all the tissues and secretions of the body, caused by impregnation with bile-pigment.

Jejunum.—Upper portion of the small intestine, twelve finger breadths in length.

K

Kidney, Bright's disease of the.—See ALBUMINURIA.

Kidneys.—Secretory organs of the urine.

L

Lachrymal (*lachryma*, tear).—Pertaining to tears.

Lacteals.—Minute tubes which absorb the chyle from the small intestine, and convey it into the circulation.

Lacuna (pl. *lacunæ*).—A small cavity in the bone structure.

Lamina (a plate).—A thin, flat part of a bone.

Laryngitis.—Inflammation of the larynx.

Larynx.—Upper part of the windpipe.

Latency.—The state of being concealed.

Lesion.—Derangement; disorder.

Leucocytes.—A term applied to corpuscles which seem to resemble each other essentially in their chemical and microscopical characters.

Ligament (*ligo*, I bind).—A band of tissue, binding the bones together.
Ligature.—A band; bandage.
Linea.—Line.
Linea aspera (rugged ridge).—A rough projection at the posterior surface of the femur, which gives attachment to muscles.
Liquor amnii.—The liquid which envelops the fœtus; the waters.
Liquor sanguinis.—A term applied to one of the constituents of the blood.
Liver.—The largest gland of the body.
Lubricate.—To oil in order to prevent friction.
Lumbar.—Pertaining to, or near, the loins.
Lung fever.—An inflammation of the lungs.
Lungs.—The chief organs of respiration.
Lunula (little moon).—The white, crescent-shaped part of the nail.
Lymph.—A yellowish, alkaline fluid secreted by the lymphatic glands.
Lymphatic glands.—Small bodies through which the lymphatics pass on their way to the thoracic duct.
Lymphatics.—Small, transparent vessels, existing in various parts of the body.

M

Malformation.—A deviation from the natural standard, in size, form, number, or situation of any part or organ of the body.
Malignant.—A term applied to a disease of a very serious character.
Malleolus (*mallus*, a mallet).—The projection formed by the bones of the leg at the ankle; ankle.
Malodorous.—Offensive.
Mammalia.—A class of animals comprehending the mammals.
Marrow.—A soft tissue found in the interior of many bones.
Mastication.—The act of chewing.
Matrix.—The womb.
Meatus.—A passage, or canal.
Mediastinum.—A membranous space, formed by the approximation of the pleuræ, dividing the chest into two parts, the one right, the other left.
Medulla oblongata.—That portion of the brain which is continuous with the spinal cord.
Meibomian glands.—Glands at the inner surface of the eyelids.
Melanosis.—A morbid deposit of black matter in the organs of the body.
Melanotic.—Pertaining to, or having the character of, melanosis.
Membrane.—An expansion of any soft tissue, or part, in the form of a thin layer, generally covering or lining some other part.
Meningitis.—Inflammation of a membrane, especially of the meninges.
Mentum.—The chin.
Mesentery.—A membrane in the abdomen, which retains the intestines and their appendages in the proper position, allowing more or less motion.

Mesocolon.—That part of the mesentery to which the colon is attached.
Micrococci.—Bacteria of a spherical form.
Micturition.—Urination, or the act of passing the urine.
Mimical.—Imitative.
Monoliths.—A pillar consisting of a single stone.
Morbid.—Diseased; opposite to healthy.
Morbid anatomy.—Anatomy of the diseased human body.
Morphology.—That which relates to the anatomical conformation of parts.
Mortification.—Gangrene.
Motile.—Having powers of self motion.
Motor.—That which imparts motion.
Motory.—Giving motion.
Mucous membrane.—The membrane that lines the alimentary canal and air passages.
Mucus.—The viscid fluid secreted by the mucous membrane.
Mummification.—The mode of preparing a mummy.
Mummy—A dead body embalmed and dried for the purpose of preservation.
Muscle.—A bundle of fibers covered by a membrane.
Muscular.—Belonging to, or relating to, muscles.
Muscular rheumatism.—Rheumatism affecting the muscles.

N

Necropsy.—Post-mortem examination.
Necrosis.—Death; mortification; especially, state of a bone, or portion of a bone, deprived of life.
Nephritis.—Inflammation of the kidneys; characterized by acute pain, burning heat, suppression or diminution of urine, etc.
Nitrogen.—A tasteless, colorless, odorless gas, forming nearly four-fifths of the air.
Nonstriated.—Smooth; unstriped.
Nutrition.—Process of absorbing into the tissues such food as will build up and repair the living tissues.

O

Obesity.—An abnormal development of fat.
Occlusion (to shut up).—Sometimes this word signifies, simply, the transient approximation of the edges of a natural opening.
Œdema.—A dropsical effusion into the cellular tissue; a disease of various organs and parts in the body.
Olfactory.—Pertaining to the smell.
Omentum (pl. *omenta*).—A membranous covering of the bowels, attached to the stomach, and lying at the anterior surface of the intestines.
Opaque.—Impervious to the rays of light; dark.
Optic.—Of, or belonging to, the eye.

Organism.—A structure composed of, or acting by means of, organs.
Origin of muscle.—The more fixed extremity.
Os.—Bone.
Os calcis.—Bone of heel.
Osseous.—Bone-like.
Osteology—That part of anatomy which treats of the nature, arrangment and uses of the bones.
Ovum.—An egg.
Oxygen.—A colorless, odorless, tasteless gas, forming 23% of the weight of the air; the active element of the air.
Oxygenation.—The process of combining with oxygen.

P

Palate.—Roof of the mouth.
Pancreas.—A large gland near the stomach, which secretes the pancreatic juice.
Pancreatic juice.—A clear, viscid fluid which aids in intestinal digestion.
Papilla (pl. *papillæ*).—A minute, thread-like projection.
Paracentesis.—The operation of tapping any cavity of the body to draw off fluid or gas.
Paralysis.—A disease in which the power of motion, or sensation, or both, is lost.
Paraplegia.—Paralysis of the lower part of the body and lower extremities.
Parasite.—An animal living in or upon another, subsisting at the expense of the latter.
Parget.—Gypsum.
Parietes.—The walls of a cavity or part of the body.
Parotid.—One of the salivary glands.
Patella.—The largest sesamoid bone in the body; the knee-pan.
Pathogeny.—The branch of pathology which relates to the generation, production and development of diseases.
Pathology.—The branch of medicine whose object is the knowledge of diseases.
Peduncles (of the brain).—Two white cords on the outside of the corpora albicantia, arising from the medullary substance.
Penniform.—Applied to muscles whose fleshy fibers are inserted at the side of a middle tendon, like the feathers of a fan on their common stalk.
Peptic.—An agent that promotes digestion.
Perforation.—The act of boring or piercing through.
Pericarditis.—Inflammation of the heart sac, or pericardium.
Pericardium.—The sac which surrounds the heart.
Perichondrium.—A membrane of a fibrous nature, which covers cartilages that are non-articular.

Perinephritic.—Pertaining to perinephritis.

Perinephritis.—Inflammation of the cellular tissue around the kidney.

Periosteum (*peri*, around; *osteon*, bone).—The dense, fibrous membrane, which surrounds the bones in the living body.

Peripheral.—Relating to the periphery or circumference; around the outside of an organ.

Peritoneum.—The serous membrane of the abdomen.

Peritonitis.—Acute inflammation of the peritoneum, attended by violent pain.

Per se.—By, or of, itself.

Perspiration.—The excretion from the skin.

Pertussis.—Whooping cough.

Peyer's glands.—Small, agiminated glands situated beneath the villous coat of the intestines.

Pharynx.—The muscular, membranous cavity at the back of the mouth.

Phlebitis.—Inflammation of the inner membrane of a vein.

Phlemasia dolens.—Milk leg.

Phonation.—The physiology of the voice.

Physiology.—The science which relates to the functions or uses of the different parts or organs of the body.

Pia mater (*pia*, tender; *mater*, mother).—A very delicate membrane covering the brain completely, enveloping the cerebellum.

Pigment.—Coloring matter.

Pituitary body.—A small, round body, occupying the sella turcica of the sphenoid bone.

Placenta.—A soft, spongy, vascular body, adherent to the uterus, and connected with the fœtus by the umbilical cord.

Plasma.—The nutritious fluid of the blood.

Pleura.—The membrane that lines the chest and envelopes the lungs.

Pleuritis, or pleurisy.—An acute or chronic inflammation of the pleura, accompanied with fever, pain, difficult respiration and cough.

Plexus.—A network of blood vessels or of nerves.

Pneumonia.—See Lung Fever.

Pneumonitis.—See Lung Fever.

Pneumo-pericardium.—A collection of air or gas in the pleura; a complaint generally sudden in its invasion and fatal in character.

Pneumo-thorax.—A collection of gas in the pleural cavities.

Pons Varolii.—An eminence at the upper part of the medulla oblongata.

Post-mortem examination.—An examination, after death, of the body for the purpose of ascertaining the cause or causes of death.

Prehension.—The act of laying hold of.

Process.—A projection.

Prophylactic.—A preservative or preventive.

Proteids.—Applied to certain food stuffs, which are primarily tissue formers.

Protoplasm.—The viscid, nitrogenous material in vegetable cells, by which the process of nutrition, secretion, and growth goes forward.

Proximal.—Toward or nearest; the end of a bone, limb, or organ nearest the point of attachment of insertion; opposed to distal.

Proximate.—Nearest; next to center of body.

Pterygo-palatine.—That which belongs to the pterygoid process and palate.

Puerperal fever.—Child-bed fever.

Puerperal peritonitis.—Inflammation of the peritoneum during parturition.

Pulmonary.—Pertaining to the lungs.

Purulent.—Consisting of pus.

Pus.—The secretion from inflamed textures.

Pustule.—An elevation of the cuticle, with an inflamed base.

Putrefaction.—A decomposition, experienced by animal substances when deprived of life; becoming putrid.

Pyæmia.—A dangerous disease produced by the mingling of the poisonous matters of pus with the blood.

Pylorus.—The lower or right orifice of the stomach.

Pyriform.—Pear-shaped.

Q

Quadratus.—Square.

R

Racemose.—Resembling a raceme; in clusters, like grapes.

Ramus.—Branch.

Receptaculum chyli.—Receptacle of the chyle; a dilation of the thoracic duct.

Rectum.—The third and last portion of the large intestine.

Recurrent (*recurrens*, returning).—To run back.

Reflex.—A term applied to an action, which consists in the reflection by an efferent nerve of an impression conveyed to a nervous center by an afferent nerve.

Regurgitation.—The act by which a canal or reservoir throws back substances accumulated in it.

Respiration.—The act of breathing.

Rete.—The name given to the interlacing and decussion of blood vessels, lymphatics, fibers and nerves, when they form a kind of network.

Rete mucosum.—The second layer of skin. It is between the *cutis vera* and cuticle, and gives color to the body.

Reticular.—Resembling a net; applied to many structures in the body.

Retina.—Innermost coat of the eye, consisting of an expansion of the optic nerve.

Rheumatism.—A painful inflammation, or neuralgia, affecting the muscles, joints and other parts of the body.

Rickets.—The arrest of natural growth and development.

Rigor mortis.—The stiffening of the muscles after death.

Rotation.—The act of rotating.

Rupture.—A preternatural opening of the walls of the abdomen with protusion of internal parts; hernia; the state of being broken, as rupture of a vessel.

S

Sacculated.—Furnished with little sacs.

Saliva.—The fluid secreted by the salivary glands.

Sanitary.—Pertaining to health.

Saprophytes.—Putrefactive bacteria.

Sarcophagus.—A tomb.

Scapula.—The shoulder blade.

Scarlet Fever—A contagious febrile disease, characterized by inflammation of the fauces, and a scarlet rash, appearing usually on the second day, and ending in desquamation about the sixth or seventh day.

Scarletina—See SCARLET FEVER.

Sclerotic.—The outer coat of the eye.

Scybala.—Feces in the form of round, hard lumps.

Sebaceous glands.—Small, conglomerate glands situated in the subcutaneous areolar tissue, either isolated, or connected with the hair follicles, which secrete the sebaceous humor.

Secretion (*secretum*, to separate).—The process of preparing and separating substances necessary for the activity and health of the body; the substances so prepared and separated.

Senility.—That condition of the body resulting from old age.

Septic.—A substance causing putrefaction.

Septicæmia—Blood poisoning.

Septum.—A part destined to separate two cavities from each other, or to divide a principal cavity into several secondary cavities.

Serous.—Thin; watery; relating to the most watery portion of animal fluids, or to the membranes that secrete them.

Serous membrane.—A thin tissue, covering the cavities of the body that are not open to external air.

Serum.—The most watery portion of animal fluids, exhaled by serous membranes.

Sesamoid bones.—Small bones situated in the substances of tendons near certain joints.

Sinus.—A cavity in a bone or other part, the interior of which is more expanded than the entrance.

Slough.—The dead material resulting from gangrene, ulceration or low forms of inflammation of soft tissues.

Smallpox.—An exanthematic disease, consisting of a constitutional febrile affection, and a cutaneous eruption.

Softening, post-mortem.—Softening after death of different organs due to post-mortem changes.

Somatic.—That which concerns the body; death of entire body.

Spinal column.—Back-bone.

Splenitis.—Inflammation of the spleen.

Splenization.—A morbid condition of the lungs in which they sometimes resemble the spleen in color and consistency.

Spores—An organized body of extremely minute size; a germ.

Spurious disease.—A disease which is mistaken for another.

Sputum.—The secretions ejected from the mouth in the act of spitting.

Steatoma.—An encysted tumor, containing matter like suet; a wen.

Steatomatous.—Of the nature of a steatoma.

Stercoraceous vomiting.—Vomiting of fecal matter.

Sterilize.—To render free from living germs, as by heating or otherwise.

Stethoscope.—An instrument employed to examine the chest sounds, in auscultation.

Striated.—Striped.

Stricture.—A contraction of a tube, duct, canal, or orifice.

Stimulus.—Anything that excites the animal economy.

Structure.—The arrangement of the different tissues and organic elements of which the body is concerned.

Subcutaneous.—That which is placed immediately under the skin.

Subjacent—Lying under or below.

Sublingual (*sub*, under; *lingual*, tongue).—The salivary gland located under the tongue.

Submaxillary (*sub*, under; *maxilla*, jaw).—The salivary gland located under the jaw.

Suffocation.—Obstruction of respiration by means other than pressure on the neck (hanging, strangulation), or submersion (drowning).

Sulcus (pl. *sulci*).—A furrow or groove; a name given to the grooves on the surface of bones or other organs.

Supinated.—Turned up.

Suppuration.—Producing purulent matter, or forming pus.

Suture.—A kind of immovable articulation, in which the bones unite by means of serrated edges, which are dovetailed into each other.

Sympathetic system.—The portion of the nervous system controlling the voluntary functions of the various organs.

Symphysis.—Articulation or union of bones.

Symphysis pubis.—Articulation of the pubis.

Syncope.—A state of suspended animation, due to sudden failure of the heart.

Synovia.—A fluid resembling the white of egg, secreted by the synovial membranes, which lubricates the joints.

Synovial.—That which relates to the synovia.

Synovial membranes.—Membranes covering the joints.

Synthesis.—The operation by which divided parts are reunited.

Synthetically.—In a synthetical manner; by synthesis.

Systemic.—Belonging to the general system.

Systemic circulation.—General circulation of the blood through the arteries, veins and capillaries.

T

Tampon.—A plug.

Temporal.—Relating to the temple.

Tendon.—A cord, or bundle of fibers, by which motion is communicated from a muscle to a bone.

Tetanus.—Lockjaw.

Thorax.—The cavity containing the lungs.

Thrombosis.—The coagulation of fibrin in the heart, or blood vessels, during life.

Thrombus.—A small, hard, round, bluish tumor, formed by an effusion of blood in the vicinity of a vein, which has been opened in the operation of blood-letting; a coagulum of blood.

Tissue.—A general term applied to the textures of which the different organs are composed.

Tonic.—A medicine which has the power of exciting slowly the organic actions of the different systems of the animal economy.

Torsion (*tortum*, to twist).—Twisting.

Tortuous.—Twisted.

Toxæmia.—Poisoning of the blood.

Trachea.—The windpipe.

Trance.—A sleep-like state which comes on spontaneously and from which the sleeper cannot be roused; must not be confounded with death.

Transude.—To pass through the pores of a texture.

Traumatic.—Anything relating to a wound.

Triceps.—A muscle with three heads or origins.

Tricuspid.—That which has three points; a name applied to the triangular valves of the heart.

Trochanter.—Name of the process at the upper extremity of the femur.

Tuberosity.—An eminence or process, with an unequal and rough surface.

Tumor.—Swelling caused by some form of new growth, such as cancer, fibroid, boil, etc.

Typhoid Fever.—A continued fever of long duration, usually attended with diarrhœa, characterized by peculiar intestinal lesions and enlargement of the spleen.

Typhus Fever.—A contagious febrile disease, marked by a peculiar, dark rash, with considerable cerebral depression, and lasting about three weeks.

U

Umbilical.—That which belongs or relates to the navel.

Umbilical cord.—A cord-like substance which extends from the placenta to the umbilicus of the fœtus.

Unctuous.—Fat, oily, greasy.

Unicellular.—Containing one cell.

V

V or **Vel.**—Or.

Vaccination.—The operation of inserting the vaccine virus under the cuticle, so that it may enter into the absorbents.

Vaccinia.—Cowpox.

Valvular.—Containing valves.

Varioloid.—Smallpox modified by vaccination.

Vasa vasorum.—Small vessels which supply larger vessels with blood for their nutrition.

Vascular.—Consisting of, or containing, vessels.

Vasomotor.—That which causes movement in the vessels.

Vegetation.—A morbid production which rises as an excrescence on an organ or part; a fleshy granulation at the surface of a wound or ulcer.

Venæ Comites.—Companion veins accompanying an artery.

Venesection.—Blood-letting.

Ventral.—Belonging to the abdomen.

Ventricle.—A cavity, especially of the heart; also, of the brain.

Vermiform appendix.—See APPENDIX VERMIFORMIS.

Vertigo.—Giddiness, dizziness, or swimming of the head.

Villi (pl. of *villus*, a tuft of hair).—Minute, highly vascular, papillary elevations projecting from the mucous membrane of the small intestine throughout its whole extent, giving to its surface a velvety appearance, and serving chiefly for absorption.

Villous membrane.—Membrane covered with fine, delicate prolongations, papillæ, or villi.

Virus.—A poison.

Viscera.—The contents of the cavities of the body, as of the head, thorax, abdomen, etc.

Viscid.—Sticky, or adhering; having a ropy or glutinous consistency.

Volatile.—Capable of wasting away; evaporation.

Voluntary muscle.—A muscle under control of the will.

W

Wormian bones.—Small bones in the sutures of the bones of the cranium.

Wry-neck.—Twisting of the neck to one side.

Z

Zygomatic.—That which relates to the cheek-bone.

Zymotic disease.—Any epidemic, endemic, contagious, or sporadic affection which is produced by some morbific principle acting on the system like a ferment.

GENERAL INDEX.

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APPENDIX.

THIRTEEN HUNDRED QUESTIONS FOR REVIEW.

NOTE:—These questions are intended for the use of the student in reviewing his studies. It is recommended that, after studying a chapter, answers be written to the questions as far as possible from memory. In this way, one's understanding of each subject will be tested and a better knowledge of the general theme acquired.

PART FIRST—THE HUMAN BODY.

CHAPTER I.—(1) How many bones in the skeleton? (2) How many bones in the head? (3) Name them. (4) How many in the trunk? (5) Name them. (6) How many in the limbs? (7) Name them. (8) How are the bones placed? (9) How classified? (10) How many long bones? (11) Short? (12) Flat? (13) Irregular? (14) What is the composition of bones at maturity? (15) In youth? (16) What is the structure of bones? (17) Describe fresh or living bones. (18) What is the outer covering called? (19) The inner? (20) What is the center? (21) What are the lacunæ? (22) What is their use? (23) What are the large tubes called? (24) When does a bone structure reach its full development? (25) Why are bones not easily fractured in childhood? (26) How are joints divided? (27) What is the synovial membrane and its use? (28) How are broken bones repaired by nature? (29) Are the bones of the skull and face movable? (30) What is the layer between the two plates of the skull bones called? (31) How are the outer bones joined? (32) What do the skull bones form? (33) What is contained therein? (34) What does the trunk contain? (35) Of what does the spinal column consist? (36) What is the general form of a vertebra? (37) How does the skull articulate with the spine? (38) How many ribs? (39) What different kinds? (40) What by their form and arrangement do they afford? (41) What do the hip bones form? (42) Give a general description of the extremities. (43) What constitutes the shoulder? (44) Describe the clavicle, and give its articulations. (45) The scapula. (46) What kind of a joint is the shoulder joint? (47) Explain it. (48) Describe the bones of the arm. (49) The wrist. (50) The hand. (51) What is the longest, largest and strongest bone of the skeleton? (52) What is its articulation with the hip bone? (53)

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CHAPTER IV. —(1) What does the nervous system include? (2) It is the medium of what? (3) Of what kinds of matter is it composed? (4) What different structures? (5) Describe each. (6) What are the nerves? (7) Ganglions? (8) What are the different kinds of nerve fibers? (9) Describe and explain the nerve current. (10) Name the nerve sensations. (11) What constitutes the sympathetic system? (12) Describe it. (13) What constitutes the cerebro-spinal system? (14) What is the brain? (15) Its weight in man? (16) In woman? (17) Give its membranes. (18) Into how many portions is it divided? (19) Describe the cerebrum. (20) How divided? (21) How many lobes? (22) Of what is the cerebrum the center? (23) What happens when the cerebrum becomes seriously injured? (24) How is

the cerebellum located? (25) It is the center for control of what? (26) Describe the medulla oblongata. (27) Its functions. (28) What will result from its destruction? (29) What nerves center therein? (30) Describe the spinal cord. (31) How many pairs of nerves does it give off? (32) Describe them. (33) Name the cranial nerves?

CHAPTER V. — (1) Of what do the organs of digestion consist? (2) What takes place within them? (3) Why is digestion necessary? (4) Describe the alimentary canal. (5) Name its subdivisions. (6) The accessory organs. (7) Describe the mouth. (8) What takes place therein? (9) Name its contents. (10) Locate and describe the salivary glands. (11) What stimulates their action? (12) What fluid do they secrete? (13) What is its use? (14) Describe the tongue. (15) What gives it its roughness? (16) What is the use of the teeth? (17) Describe them. (18) Give number and division. (19) Describe the jaws. (20) What is the pharynx? (21) How located? (22) Name its openings. (23) What and where is the esophagus? (24) Describe the stomach. (25) What is its capacity? (26) What is its location? (27) Of what is its wall composed? (28) What takes place when food enters the stomach? (29) Describe the action of the stomach during digestion. (30) What becomes of the digested portion of food? (31) How long a time is required for stomach digestion? (32) What are the two ends called? (33) The openings? (34) What guards the lower opening? (35) What is the small intestine? (36) What is the food called when it enters the intestine? (37) What takes place therein? (38) What cover the interior membrane? (39) What are their use? (40) What coats has the small intestine? (41) What are contained in the mucous coat? (42) Name the subdivisions of the small intestine. (43) Why is the duodenum so called? (44) Describe it. (45) The jejunum. (46) The ileum. (47) The large intestine. (48) What is its chief office? (49) Name its subdivisions. (50) What is the cæcum? (51) What guards the entrance of the small intestine? (52) What is the appendix vermiformis? (53) What is its use? (54) Into what parts is the colon divided? (55) Locate and describe each. (56) What is the sigmoid flexure? (57) What is the rectum? (58) Wherein does it differ from the other portions? (59) What is the liver? (60) Give its weight and size. (61) What is its principal use? (62) Into how many lobes is it divided? (63) Describe the gall bladder. (64) What is its secretion? (65) What is the use of the bile? (66) What is the pancreas? (67) What its secretion? (68) How does the latter act? (69) Describe the location of the pancreas. (70) What is the use of the pancreatic duct? (71) What are the ductless glands? (72) Describe each. (73) What is the largest cavity of the body? (74) Locate it. (75) Give its contents. (76) How is it bounded? (77) How is the abdomen artificially divided? (78) Name the regions.

(79) Name the contents of each in order. (80) Describe the peritoneum? (81) Peritoneal sacs. (82) Omenta. (83) Mesenteries. (84) What are the contents of the pelvic cavity?

CHAPTER VI.—(1) Of what do the organs of respiration consist? (2) What is the respiratory tract? (3) Describe the nasal passages. (4) Why should you breathe through the nose? (5) What is the pharynx? (6) The larynx? (7) What are the cartilages of which it is composed? (8) What are the vocal cords? (9) The glottis? (10) The epiglottis? (11) The trachea? (12) What keeps it in shape during the act of breathing? (13) What are its divisions called? (14) What are the bronchial tubes? (15) The bronchioles? (16) Describe each. (17) What are the lungs? (18) What do they weigh? (19) What is the color of the lungs at birth? (20) What changes take place during life? (21) What is the structure of the lungs? (22) How are the lungs nourished and how supplied with blood for oxygenation? (23) Describe the pleuræ.

CHAPTER VII.—(1) How is the wearing away of the organs and tissues of the body constantly being repaired? (2) How is this done? (3) What is circulation? (4) What are the organs of circulation? (5) How are the blood vessels divided? (6) Describe the heart. (7) Give its location. (8) What is the pericardium? (9) The endocardium? (10) What is the heart's weight and size? (11) Name its cavities. (12) Is there any communication between the two halves? (13) Which is the venous side? (14) Into which cavity is the blood received? (15) What is its course thereafter? (16) What takes place in the lungs? (17) Where does the blood go from the left ventricle? (18) What is the heart's capacity? (19) How frequently does the pulse beat? (20) What is the weight of the blood in a body? (21) Describe the right auricle. (22) Right ventricle. (23) Left auricle. (24) Left ventricle. (25) What are the semi-lunar valves? (26) The mitral valve? (27) What is the blood? (28) What is its office? (29) Of what is it composed? (30) What is the plasma? (31) What is its use? (32) What do the red corpuscles contain? (33) What are their uses? (34) Give the course of the blood after leaving the heart. (35) What is its color while in the arteries? (36) What is its color on being returned to the heart? (37) What does arterial blood contain? (38) Impure blood? (39) What does the impure blood lose in passing through the lungs? (40) What does it take up? (41) What are the arteries? (42) Describe and give coats. (43) What accompany them? (44) How are the outer coats nourished? (45) What is collateral circulation? (46) How many kinds of circulation are there? (47) What are they? (48) What is the main trunk of the systemic circulation? (49) Locate and describe. (50) How is it divided? (51) What arteries are given off from the arch? (52) The thoracic aorta? (53)

The abdominal aorta? (54) What are the subdivisions of the cœliac axis? (55) Give location and use of the coronary arteries. (56) What are the location and subdivisions of the innominate? (57) Describe origin and course of the common carotid arteries. (58) What is the course and branches of the external carotid? (59) What do the branches supply? (60) Describe course of the internal carotid. (61) Name its branches. (62) What is the circle of Willis? (63) Describe origin and course of the subclavian. (64) Vertebral. (65) Internal mammary. (66) Of what is the axillary the continuation? (67) What do its branches supply? (68) Where does the brachial begin? (69) Into what does it divide? (70) Describe the radial. (71) Ulnar. (72) What is the superficial arch? (73) Deep palmar arch? (74) What is the course of the thoracic aorta? (75) Name its branches. (76) Give course and termination of the abdominal aorta. (77) Name its branches. (78) Give course and termination of the common iliacs. (79) Describe the internal iliac. (80) External iliac. (81) Describe branches of latter. (82) Give location and course of femoral. (83) Name its branches. (84) Locate and give divisions of the popliteal. (85) Describe the anterior tibial. (86) Dorsalis pedis. (87) Posterior tibial. (88) Internal and external plantar. (89) What kind of blood do the pulmonary arteries carry? (90) Describe them. (91) Describe the branches. (92) What are veins? (93) Name the coats. (94) What do veins carry? (95) What are the venæ comites? (96) How do veins anastomose? (97) What do the venous valves do? (98) What are sinuses? (99) Into what systems are veins divided? (100) What veins have no valves? (101) What are the principal veins of the head and neck? (102) Name and describe veins of neck draining above. (103) Describe the veins of the upper extremities. (104) What are the principal veins of the thorax? (105) Describe them. (106) Describe the subclavian. (107) Innominate. (108) Superior vena cava. (109) Name and describe superficial veins of the lower extremities. (110) Describe the common iliac. (111) Inferior vena cava. (112) What is the portal system? (113) Describe its veins. (114) What is the use of the pulmonary system? (115) Describe the capillaries. (116) Where do they exist? (117) What is their use? (118) What is the fœtal circulation? (119) Give course of the blood. (120) How does oxygenation of the blood take place in the fœtus? (121) What is the difference in the heart before and after birth? (122) In the lungs?

CHAPTER VIII. — (1) Describe and locate the eye. (2) What are its membranes? (3) Describe each. (4) What is the vitreous humor? (5) Describe and locate the crystalline lens. (6) The aqueous humor. (7) Describe the retina and its different parts. (8) Describe the iris. (9) How does light enter the eye? (10) How is the quantity of

light regulated? (11) What is the use of the pupil? (12) What determines the color of the eye? (13) Describe the eyelids. (14) Eyelashes. (15) What is the use of the substance secreted by the Meibomian glands? (16) Describe the lachrymal glands. (17) What is the use of tears? (18) How is the surplus disposed of? (19) Of what is the ear the organ? (20) Of what parts does it consist? (21) Describe the external ear. (22) What is the auditory canal? (23) The drum? (24) How is it kept soft and elastic? (25) Describe the middle ear. (26) The bones of the ear. (27) How are they attached? (28) What separates the middle and internal ear? (29) Describe the eustachian tube. (30) The internal ear. (31) The labyrinth. (32) Name contents of latter. (33) Describe the nose. (34) Of what is the tongue the organ? (35) What other "special sense?"

CHAPTER IX.— (1) Name weight of the principal parts of a body. (2) What is the chief constituent? (3) What percentage does it form? (4) Name the other constituents in order. (5) Name their gaseous constituents. (6) Give percentage of the ultimate elements. (7) What is the percentage of gaseous and what of solid elements? (8) In what condition does the oxygen and hydrogen exist? (9) What is the daily loss in grains? (10) What are the daily gains? (11) How much food is required daily? (12) What is the rate of movement of blood in the great arteries? (13) Capillaries? (14) What time is required to make the entire circuit? (15) What is the vital capacity of the chest? (16) What quantity of air passes through the lungs daily? (17) What amount of oxygen is consumed in twenty-four hours? (18) Amount of carbonic gas produced?

PART SECOND — ANCIENT AND MODERN EMBALMING.

CHAPTER X.—(1) What people first embalmed its dead so far as history gives us knowledge? (2) What reasons probably led to this disposition? (3) What part did religion play? (4) To what fraternity did their embalmers probably belong? (5) What was first done with the body after death? (6) How was the style of preparation decided? (7) What different methods for removing the brain are mentioned? (8) What was the duty of the scribe? (9) The paraschistes? (10) What instrument did the latter use? (11) What followed the completion of his work? (12) Describe the knife used. (13) Was the pursuit of the paraschistes a religious formality? (14) What viscera were removed? (15) What not? (16) What was done with the entrails? (17) How was the cavity cleansed? (18) What was afterwards done with the entrails? (19) With what was the body anointed? (20) How was the body swathed? (21) How was the body of a Pharoah or other sacred person treated? (22) What was the cost of the most magnificent styles of embalming? (23) Describe the cartonnage and other

cases. (24) How were they ornamented? (25) What kinds of sarcophagi were used? (26) How were the intestines finally disposed of? (27) Into what two classes was Egyptian Embalming divided? (28) Describe each. (29) Describe the intermediate grade. (30) What was the cost? (31) What was done with the body of a stranger? (32) When did embalming cease in Egypt? (33) Describe the Jewish methods. (34) How were the poor embalmed? (35) How did the Romans embalm? (36) Babylonians? (37) Ethiopians? (38) What other nations practiced the art? (39) How about the Guanches? (40) Ancient Peruvians? (41) Aztecs? (42) Early North American Indians? (43) Why was embalming discontinued by early Christians?

CHAPTER XI.—(1) What progress has been made in embalming during the present century? (2) Who was Dr. Frederic Ruysch? (3) Explain his method. (4) What about its success? (5) Who was Dr. Wm. Hunter? (6) Give his method. (7) What happened at the end of four years? (8) Tell about John Hunter. (9) Where are the most perfect specimens of modern embalming to be found? (10) Who followed in the practice of the Hunterian methods? (11) Give the modifications of each. (12) Explain M. Boudet's process. (13) M. Franchini's. (14) Who was Jean Nicholas Gannal? (15) Give his various methods. (16) What about his secret formula? (17) Of what did his prohibited solution consist? (18) What was M. Sucquet's successful method? (19) Name the preparations used by MM. Sucquet, Gannal and Dupre in their contest. (20) Explain M. Falcony's desiccatory process. (21) What was Dr. Chaussier's method? (22) Give Franciolla's formula. (23) Describe his practice. (24) What was Brunetti's method? (25) The method in vogue in Belgium? (26) How did Dr. Tscheirnoff treat the abdominal and thoracic cavities and viscera? (27) How the skull and brain? (28) What preparations were used? (29) What was the Florentine process? (30) The German method? (31) Is embalming much practiced in England to-day?

CHAPTER XII.—(1) How do the methods of to-day compare with those of three hundred years ago? (2) Quote the substance of Dr. McCurdy's opinion. (3) Who is called the "father of embalming" in this country? (4) What are the chief reasons for embalming? (5) Why is preservation of the body for a time desired? (6) Why should sanitation be the chief reason for embalming? (7) What should health boards do? (8) How may contagion be spread if thorough embalming is not practiced? (9) What should be considered before commencing the operation of embalming? (10) How soon after death should the operation be commenced? (11) What are the different steps in brief? (12) What should be done to thoroughly embalm? (13) Should blood be withdrawn? (14) How treat the cavities? (15) Should both arterial and cavity injection be practiced at the same

time? (16) What is the appearance of the body after thorough embalmment? (17) What do the changes which take place indicate? (18) In what class of cases is more than one injection necessary?

CHAPTER XIII.—(1) What are the two chief modes of death? (2) What is usually described as the third? (3) Is it always easy to determine when life is extinct? (4) What conditions resemble those of death? (5) What is the most reliable sign of death? (6) How is this proof secured? (7) What is the test of a tight ligature on a finger or toe? (8) What are the tests to determine if respiration has ceased? (9) Explain condition of the body if death is really present. (10) How about the cooling of the body? (11) What is hypostasis? (12) Post-mortem staining? (13) Rigor mortis? (14) Does rigor mortis always take place after death? (15) How long does it last in different cases? (16) What causes putrefaction? (17) What are the first indications? (18) What happens in the course of time? (19) What accompanies the process of putrefaction? (20) How long does it take for a body to decompose? (21) What conditions of temperature modify the time? (22) What tissues are the last to putrefy?

CHAPTER XIV.—(1) What are the nutrient fluids of the body? (2) Which is the most important to the embalmer? (3) What prevents its entire removal? (4) What is the color of blood when pure? (5) When impure? (6) What are its constituents? (7) Describe the red corpuscles. (8) White corpuscles. (9) What happens to the blood after death? (10) How soon after death does it coagulate? (11) Where is the blood found chiefly after death? (12) Why? (13) Where are coagula found? (14) What is the condition in the capillaries and small veins? (15) Where does the blood gravitate? (16) What prevents or retards coagulation? (17) Why should blood be quickly removed? (18) What is the proportion of the blood to the weight of the entire body? (19) What is its weight? (20) What is necessary to a good understanding of the circulation of blood? (21) What vessels carry blood away from the heart? (22) What to the heart? (23) What arteries carry venous blood? (24) What veins carry arterial blood? (25) What is this last circulation called? (26) Describe course of the blood in the systemic circulation. (27) Why are the arteries found empty? (28) What portions first lose irritability? (29) How long does this rigidity continue? (30) Is the caliber of the arteries affected by their contraction? (31) Does this contraction affect the flow of fluid? (32) Is the circulation of fluid exactly the same as that of the blood? (33) Does it ordinarily pass into the heart? (34) Why not? (35) Will it if a needle process is used? (36) Describe the course of the fluid if the right brachial artery is injected. (37) What part of the system does it reach last?

CHAPTER XV.— (1) What has the development of embalming

brought into existence? (2) What about the latitude in selection of instruments? (3) How may one's ability as an embalmer be judged? (4) Why should instruments be kept clean? (5) What often results from handling filthy instruments? (6) What class of disorders especially results? (7) Why should aseptic instruments be used? (8) Define aseptic. (9) What kind of instruments are aseptic? (10) Are they more costly? (11) In what does the progressive physician especially pride himself? (12) Should the embalmer likewise? (13) Should his instruments be on a plane with his other paraphernalia? (14) What is sterilizing instruments? (15) Give the formula. (16) Give process for removing rust from steel instruments. (17) Why should instruments be kept sharp? (18) What about the number and quality of instruments to be possessed? (19) What instruments are necessary for arterial work? (20) For cavity injection?

CHAPTER XVI.—(1) What arteries should be selected for injection in a male subject? (2) Why should the femorals be avoided in a female subject? (3) Why is it generally best to avoid the common carotids? (4) Why is the left brachial preferred to the right? (5) How proceed if it becomes necessary to raise the femoral in the female? (6) What artery should be used in either sex when the body is dressed? (7) What should the embalmer be acquainted with to raise an artery? (8) What are found in the same sheath with the artery? (9) Describe the appearance and condition of the artery. (10) Vein. (11) Nerve. (12) What arteries are usually selected? (13) How should the incision be made? (14) How the dissection? (15) How should the wall of the artery be incised? (16) In which direction should the arterial tube be inserted? (17) What is the next step? (18) What is the distal end of an artery? (19) Proximal end? (20) What should be done if fluid appears at the distal end? (21) What if it does not? (22) How much time should be taken? (23) What may happen from rapid or careless work? (24) Give the location of the brachial artery and basilic vein. (25) How may the brachial artery vary from its regular course? (26) How may it divide? (27) What is the linear guide? (28) Anatomical guide? (29) On what muscle does it border? (30) What other muscle forms a part of the groove in which it lies? (31) What is its covering? (32) How should the arm be held? (33) Where should the incision be made? (34) Give relative situation of artery, vein and nerve. (35) What is done if blood is to be removed? (36) Give the full operation. (37) How much fluid should be injected? (38) Where is the femoral artery situated? (39) Between what points does it extend? (40) Give linear guide. (41) Anatomical guide. (42) On what muscle does it border? (43) Through what does the artery pass in the upper part of its course? (44) How is Scarpa's triangle bounded?

(45) Where should the incision be made to raise the artery or vein? (46) How make the dissection? (47) What should be done if blood is to be withdrawn? (48) What is the next step? (49) What should be done if another injection may be necessary? (50) What if not? (51) Has the common carotid any advantage over other arteries? (52) Where is it situated? (53) Between what points does it extend? (54) What is likely to result in raising it? (55) How may this be somewhat modified? (56) When should it be used? (57) What is the linear guide? (58) Anatomical guide? (59) Along what muscle is it located? (60) Where should the incision be commenced to raise the artery and internal jugular vein, and how long continued? (61) What results from inserting a drainage tube into the vein? (62) Give the process for raising, incising and injecting the artery. (63) What is the advantage in selecting the radial artery? (64) What point is usually selected for raising it? (65) How is it situated at this point? (66) What length incision should be made? (67) Can it be raised higher up? (68) How is it there situated? (69) Describe the process. (70) What should be done with the wrist? (71) What should be done after sufficient fluid has been injected? (72) Where is the tibial artery located? (73) It extends between what points? (74) Where should the incision be made to raise it? (75) Describe the further process. (76) How should the body be placed after the injection is completed? (77) Why? (78) Why should the blood be removed? (79) What are the different methods for removing it? (80) What is required to remove blood from the heart? (81) What should be the length, kind and condition of the needle? (82) Where should the needle be introduced? (83) In what direction pointed? (84) To what depth inserted? (85) What part of the heart will be entered? (86) What is the next step? (87) What should be the position of the body during the process? (88) Why? (89) What should be done to remove the blood from the lower extremities? (90) How is the vacuum in the heart filled? (91) Does tapping the heart destroy the circulation? (92) Why not? (93) What may result from the heart occupying an abnormal position or being diseased? (94) Do the valves of the heart and veins act after death as before? (95) What do they prevent? (96) Does fluid enter the left cavities of the heart? (97) Under what circumstances does it enter the right side? (98) How is the substance of the heart supplied? (99) What is required to remove blood by the veins? (100) Why is it best to select the vein accompanying the artery chosen for injection? (101) Explain the process if the basilic vein is chosen. (102) Femoral vein. (103) Internal jugular vein. (104) What caliber vein tube should be used in each case? (105) What should be done if the blood is coagulated or does not flow freely? (106) When is the proper time

to remove the blood? (107) When is a second injection necessary? (108) What happens in the course of a day or two? (109) What is "skin slip?" (110) What causes it? (111) In what kind of diseases does it usually occur? (112) How is it disproved that some kinds of fluids produce "skin slip?" (113) How can "skin slip" be prevented? (114) What is the formula and treatment? (115) When do discolorations take place? (116) What cause them? (117) What may cause congestion of the head, neck and face? (118) What may result at the same time in the abdominal and thoracic cavities? (119) What treatment should be resorted to? (120) If not successful, what treatment should then be resorted to? (121) How remove "flushing of the face?" (122) Greenish or brownish spots? (123) Bruised and other spots? (124) When does discoloration by biliverdin take place? (125) How caused? (126) Can it be removed? (127) Should bleachers and fluids be used on the face? (128) What is the formula for the ice mixture? (129) How should it be applied and for how long? (130) What substitute can be used?

CHAPTER XVII.— (1) Can cavity injection alone be relied upon? (2) Why not? (3) Should it be used as an auxiliary to arterial injection? (4) Bound the chest. (5) Into how many cavities is it divided? (6) And by what organs? (7) What are the contents? (8) What are the pleuræ? (9) Describe them. (10) At what point should the trocar be introduced to inject the pleural cavities? (11) How proceed? (12) How can both cavities be injected from the same point? (13) How much fluid may be injected? (14) What kind of a trocar should be used? (15) At what other point may the injection be made? (16) How may the lung tissue be injected? (17) What should be done in all cases of consumption and lung fever? (18) At what point should the needle be inserted to inject the abdominal cavity? (19) How much fluid should be used? (20) How inject the stomach and intestines? (21) How proceed to remove gases from the thoracic cavity? (22) From the abdominal cavity? (23) How proceed to remove liquids from the abdominal cavity?

CHAPTER XVIII.— (1) Who first introduced the needle process into this country, and when? (2) What is the method? (3) By what name is it known? (4) Explain the operation. (5) What should be the position of the body? (6) How begin the injection? (7) What is the objection to this method? (8) What may result? (9) Is this result serious? (10) How may it be prevented? (11) How proceed to inject through the foramen magnum? (12) Has this operation any advantages over other needle processes? (13) What needle process is attended with the least danger? (14) What is the Champion Needle Process? (15) Describe the operation. (16) What should be the position of the body? (17) How does

the fluid enter the vascular system by this process? (18) Where does the fluid reach first, and how is it distributed? (19) Should this method take the place of arterial embalming? (20) When is its use recommended? (21) How can the skull be quickly drilled?

PART THIRD—MORBID ANATOMY.

INTRODUCTORY REMARKS.— (1) Are the morbid changes which take place in the body after death generally known by the embalmer? (2) How about his knowledge of the condition of the visceral organs and tissues? (3) What is very essential? (4) Define Morbid Anatomy. (5) What is shown by Part Third?

CHAPTER XIX. — (1) What class of diseases are treated in this chapter? (2) What is smallpox, and how produced? (3) What is the morbid anatomy? (4) Should such cases be injected? (5) Why? (6) How may an epidemic be caused in after years? (7) How should the body be prepared? (8) Should this method be observed in all cases of contagious diseases? (9) What is scarlatina? (10) What should be the treatment? (11) How is diphtheria caused? (12) Where is it most prevalent? (13) What are the morbid characteristics? (14) What the treatment? (15) What is the origin of typhus fever? (16) What is the morbid condition when death occurs early in the disease? (17) What if later? (18) What complications may there be? (19) What part of the body do the typhoid bacilli especially attack? (20) What are other morbid conditions? (21) What should be the treatment? (22) What when death occurs later? (23) Should the treatment be very thorough? (24) Why? (25) What is typhus fever? (26) Why called ship fever? (27) What bacilli are peculiar to this disease? (28) What are the morbid appearances? (29) What is the treatment? (30) What is tuberculosis? (31) To what due? (32) What are the morbid changes? (33) What may be the condition of the lungs? (34) What complications may attend the disease? (35) What should be the treatment? (36) What bacteria produces Asiatic cholera? (37) Who first made the discovery, and when? (38) How may the disease be communicated? (39) What are the morbid appearances? (40) What about muscular contraction? (41) Describe the case reported by Barlow. (42) What is the color of the peritoneal coat? (43) Where are the comma bacilli found? (44) Describe the treatment. (45) Why is yellow fever so called? (46) In what localities is it most prevalent? (47) What will arrest it? (48) What are the morbid appearances? (49) Describe the case reported by Dr. Dowler. (50) What treatment should be followed? (51) To what is cerebro-spinal meningitis due? (52) What is the morbid anatomy? (53) The treatment? (54) To what age is cholera infantum peculiar? (55) Give the post-mortem anatomy.

(56) The treatment. (57) What process of injection is recommended?

CHAPTER XX.—(1) What class of diseases is treated in this chapter? (2) Septicæmia usually follows what? (3) What is the morbid anatomy of this disease? (4) How does Davaine describe this disease? (5) What does Watson say of the disease? (6) What happens when septicæmia originates from an external wound? (7) What does microscopy show? (8) What is the treatment? (9) To what is pyæmia due? (10) From what does it result? (11) What is the external appearance of the body? (12) What is the condition if the disease has been protracted? (13) Describe other morbid conditions. (14) What should be the treatment? (15) What is peritonitis? (16) What is the post-mortem condition? (17) What diseases may be mistaken for peritonitis? (18) What is the treatment? (19) From what does puerpural or childbed fever usually result, and when? (20) What are always present? (21) What is the morbid anatomy? (22) Give the treatment in full. (23) Into what classes is erysipelas usually divided? (24) Describe the morbid conditions. (25) How is erysipelas spread? (26) In what may it result? (27) How should the body be treated? (28) What important discovery has recently been made concerning sunstroke? (29) What did the investigations show? (30) With what fluids of the body were experiments made? (31) What were the tests? (32) Give the anatomical characters. (33) The treatment. (34) What is gangrene? (35) What aged people does it attack? (36) Give the morbid anatomy. (37) How does decomposition proceed in a limb? (38) What should be the treatment? (39) How may ordinary post-mortem cases be sucessfully treated? (40) How if the body is to be shipped? (41) What should be done with cancerous tumors?

CHAPTER XXI.—(1) What class of diseases is considered in this chapter? (2) What kind of a disease is pneumonia? (3) What ages are susceptible? (4) What bacteria is peculiar to it? (5) What is the morbid condition if death occurs early in the disease? (6) What is shown on section? (7) What is the condition during the stage of red hepatization? (8) What is shown on section? (9) What is the condition in the stage of gray hepatization? (10) What is shown on section? (11) Name other morbid characteristics. (12) Describe the full treatment. (13) What have some inexperienced embalmers advised to stop purging from the lungs and stomach? (14) Is such advice good? (15) What is gangrene of the lungs? (16) What is the treatment? (17) What is primary pleurisy? (18) What is the morbid anatomy? (19) What is purulent pleurisy? (20) What is it sometimes called? (21) What are the morbid characteristics? (22) Give the treatment. (23) What is pericarditis? (24) What

is the morbid anatomy? (25) The threatment? (26) What is pneumo-pericarditis? (27) Give the treatment. (28) What is the morbid anatomy of valvular diseases of the heart? (29) How are the aortic and mitral valves affected? (30) When does enlargement of the heart occur? (31) What may result from disease of the aortic valves? (32) What other conditions follow? (33) Give treatment. (34) How should laryngitis, bronchitis, etc., be treated?

CHAPTER XXII.— (1) What class of diseases is treated in this chapter? (2) What causes obstinate constipation? (3) Describe the morbid characteristics. (4) What may be found in the sigmoid flexure? (5) Of what is this fecal matter sometimes composed? (6) Describe the treatment. (7) What is dysentery? (8) Give the morbid characteristics. (9) The treatment. (10) What is appendicitis? (11) Where located? (12) Give morbid anatomy. (13) The treatment. (14) What morbid changes in hernia or rupture? (15) What is sporadic cholera? (16) What are the morbid appearances? (17) The treatment? (18) Give morbid changes in gastritis, enteritis and similar diseases? (19) Cancer may involve what? (20) Give the treatment.

CHAPTER XXIII.— (1) What are the diseases described in this chapter? (2) What are the different forms of Bright's disease? (3) What do we have as a result? (4) What are later changes? (5) What weight may the kidney attain? (6) What are other characteristics? (7) Give the treatment. (8) How should the body be handled if the skin is inclined to slip? (9) Describe nephitis. and give treatment. (10) What is diabetes? (11) Is it a disease of the kidneys? (12) What do these organs do? (13) Give anatomical characters? (14) Give the treatment. (15) Of what morbid conditions may the bladder be the seat? (16) Give the treatment.

CHAPTER XXIV.— (1) What diseases are described herein? (2) What is paralysis? (3) To what are the different forms of paralysis of common occurrence due? (4) What is a prominent feature of paralysis originating in one side of the brain? (5) What is this form called? (6) How is this paralysis of one side of the body caused? (7) What lesions give rise to hemiplegia first? (8) Second? (9) Third? (10) Fourth? (11) Fifth? (12) What is paraplegia? (13) To what form is the name paralytic stroke applied? (14) Which parts of the body are usually affected? (15) What are the special lesions causing hemiplegia? (16) From what may anæsthesia result? (17) Give the treatment in full. (18) At what age is there most liability to apoplexy? (19) Which sex is more subject to it? (20) What are the morbid characteristics? (21) What should be the treatment?

CHAPTER XXV.— (1) What diseases are herein treated? (2) What is alcoholism? (3) What has resulted from the inquiries and pathological observations of Drs. Roesch and Ogston? (4) Give a

summary of the results of their investigations. (5) What two orders of changes result from intemperance in use of alcoholic fluids? (6) What results when spirituous liquors are introduced into the stomach? (7) What follows? (8) Describe delirium tremens. (9) Give the treatment. (10) Of what is dropsy the result? (11) Name different varieties. (12) Give the morbid characteristics. (13) How about a case of general dropsy? (14) In treating, how should the body be placed? (15) What is the most common kind of dropsy? (16) How relieve the body of water? (17) What should be done when the intestines and stomach are in a floating condition? (18) What should be the treatment when water is located in the limbs? (19) How proceed to remove it from the hands and arms? (20) From the lower limbs? (21) What about drawing blood? (22) When is a second injection necessary? (23) Is it necessary to open the body to remove water? (24) How proceed to remove water from the pleural cavities? (25) How from the face? (26) What is jaundice? (27) When does it occur? (28) What causes the peculiar color? (29) Give the treatment. (30) Does acute rheumatism often result in death? (31) To what are the immediately fatal cases usually due? (32) What incidental diseases are usually responsible for death? (33) What form of inflammations are complications of rheumatism? (34) Give the treatment. (35) What is meant by a tumor? (36) What size do cystic tumors of the ovary attain? (37) What about their walls? (38) The condition, color and quantity of the contents? (39) What are encysted tumors? (40) In treating, where introduce the trocar? (41) How proceed? (42) What should be done when the tumor is on the surface? (43) Is it necessary to remove tumors from the abdomen? (44) What are the different kinds of cancers? (45) What may be the condition of the surface of an external cancer? (46) When located on the face? (47) How should internal cancers be treated? (48) How treat external cancers when the skin is broken? (49) How proceed if sloughing has resulted in destroying the features? (50) How treat the arteries and cavities? (51) What is syphilis? (52) What is the morbid anatomy? (53) How may the disease be spread? (54) What care should be taken in treating such cases? (55) Give the treatment. (56) On what does the condition of the child and surrounding tissues depend in the case of the death of the mother and fœtus? (57) What are the morbid changes if death occurs early in pregnancy? (58) If at the full period? (59) Give treatment.

CHAPTER XXVI.—(1) What class of deaths is considered in this chapter? (2) On what does the difficulties of a drowned case depend? (3) How treat if the body has been in the water twenty-four hours or less? (4) What is a "floater?" (5) How treat? (6) How much fluid can be injected? (7) How proceed if there is plenty of time for

additional treatment? (8) What preparation should be used? (9) By what time will the body be in a satisfactory condition? (10) Can the peculiar discoloration existing in a floater be removed? (11) In deaths from lightning and electricity what does a post-mortem examination show? (12) What are some of the effects of electricity in passing through the body? (13) When does decomposition begin? (14) Describe the treatment. (15) What often results from railroad and other similar accidents? (16) How vary the treatment from the ordinary? (17) What should be used over the body and all mutilated parts? (18) What should be done with gashes and cuts? (19) Bruises and discolorations? (20) How treat a body when co-aptation of the parts is impossible? (21) How proceed with gunshot wounds in the head? (22) What should be done when the fluid issues clear from the wound? (23) In what condition should the body be allowed to remain? (24) How should the wounds be prepared? (25) What is asphyxia? (26) What cause it? (27) What are the anatomical characters? (28) Describe the treatment. (29) Why is poisoning from opium and morphine frequent? (30) What are the post-mortem changes in such cases? (31) Outline the treatment. (32) Why does the inhaling of carbonic acid prove fatal sooner or later? (33) Where does it accumulate? (34) In what condition is it rapidly fatal? (35) What is the morbid condition? (36) The treatment? (37) To what is death by charcoal fumes due? (38) Under what circumstances are such deaths liable to occur? (39) Give the morbid characteristics. (40) The treatment. (41) How does death by coal gas often occur? (42) What is noticeable on opening the body? (43) Other morbid characters? (44) Give treatment.

PART FOURTH — SANITATION AND DISINFECTION.

CHAPTER XXVII.—(1) What is the common mode of infection in tatanus, erysipelas, hospital gangrene, etc.? (2) How may tuberculosis be transmitted? (3) May infection occur through the unbroken skin? (4) Through the mucous membrane of the respiratory organs? (5) How did Buchner demonstrate this? (6) What was the result of his experiments? (7) How was it proven that infection did not occur through the mucous membrane of the alimentary canal? (8) How else was it demonstrated that infection occurred through the lungs? (9) What is said about the susceptibility of single species of bacteria and the immunity from such pathogenic action possessed by other animals? (10) What has been demonstrated as to single infectious diseases prevailing only or principally among a certain species of animals? (11) What diseases are exampled as confined to man and what to the lower animals? (12) May susceptibility and immunity be a family or race characteristic? (13) Give illustrations. (14) What does a

single attack of an infectious disease in man usually confer? (15) Of what diseases is this true? (16) Name the diseases in which second attacks not infrequently occur. (17) How about such diseases as diphtheria, erysipelas and gonorrhea? (18) In what class should croupous pneumonia be placed? (19) In what localized infectious diseases does one attack give immunity? (20) Into what two classes may infectious diseases be divided? (21) How about eruptive fevers and specific, febrile, infectious diseases generally? (22) Do second attacks of smallpox and scarlet and yellow fever ever occur? (23) What ultimately occurs in such diseases as gonorrhea and erysipelas? (24) Do second attacks of diphtheria, cholera and epidemic influenza ever occur in the same epidemic? (25) What immunity does a mild attack of smallpox, scarlet fever, yellow fever, etc., give?

CHAPTER XXVIII.—(1) Who gave birth to the study of bacteriology? (2) In what year? (3) What progress has been made in this line during the past twenty years? (4) For how long a time was it developing? (5) To what does modern hygiene owe much of its value? (6) Give a sketch of Leeuwenhoeck. (7) How did he make his discoveries? (8) What important fact did he publish in 1675? (9) What did his continued research discover in various other materials? (10) In what substances did he discover these organisms? (11) What of his discovery in tartar scraped from between the teeth? (12) To whom and when did he contribute this discovery? (13) What is the particular importance of this paper? (14) What did he see everywhere distributed through the material he was examining? (15) Was his work speculative or objective? (16) Did Plenciz confirm Leeuwenhoeck's discoveries? (17) What relationship did he find between the micro-organisms discovered by Leeuwenhoeck and infectious diseases? (18) What did he claim infection to be? (19) How did he explain the variations in the incubation period of different infectious diseases? (20) What did he believe as to the multiplication of these micro-organisms in the human body? (21) What of their transmission through the air? (22) What did he teach as to a special germ for each disease? (23) What law did he formulate as to decomposition? (24) How were his arguments considered? (25) How did Ozanam express himself in 1820? (26) What were the opinions of many other medical men during this time? (27) When was the true relation of the lower organisms to infectious diseases scientifically established? (28) How? (29) What discoveries especially aroused attention to the question of animal contagion? (30) Who first logically taught the doctrine of infection? (31) What principal point occupied the attention of scientists up to this time? (32) What did one side claim? (33) What doctrine did Needham hold in 1749? (34) What was his experiment with a grain of barley?

(35) What did Spallanzani demonstrate in 1769? (36) What objections were raised to this method? (37) How did Spallanzani meet these? (38) Was much advance made up to 1836? (39) Who then called renewed attention to the subject by his investigations? (40) What were his experiments? (41) How did Schwann in the following year rob air of its organisms? (42) What were the methods of Schröder and Von Dusch? (43) What did Hoffman in 1860 and Pasteur in 1861 demonstrate? (44) Was the theory of spontaneous generation still held? (45) Whose investigations finally disproved this theory? (46) What did Prof. Tyndall demonstrate? (47) What are the forms of bacteria? (48) How are they developed? (49) How grouped? (50) What are the divisional names? (51) What is the duration and vitality of spores? (52) How does the sporific state compare with the mature state? (53) What is the effect of drying or drowning on active microbes? (54) On spores? (55) Upon what fact does the importance of spore formation depend? (56) What facilitates their diffusion and the dissemination of diseases? (57) What is an antiseptic? (58) Its disinfective properties?

CHAPTER XXIX.—(1) What may be said about the obscurity hanging over the cause of smallpox? (2) What is now the only source of the disease? (3) How is its poisonous material given out? (4) What does this material contain, and to what may they attach themselves? (5) For how long a time do these stuffs retain the poison? (6) At what period is the poison generated by the patient's person? (7) When is this poison most powerful? (8) What of the dried crusts of the pustules? (9) What of the dead body of a variolated person? (10) What is the infectious distance around a patient's room? (11) How has the fact of the contagious nature of smallpox been fully demonstrated? (12) What is the singular law of the introduction of variolus poison by means of the cutaneous tissue? (13) What is the first cause which predisposes to smallpox, or increases the susceptibility of infection? (14) Second? (15) Third? (16) What are such persons called? (17) What is the fourth cause? (18) Fifth? (19) Sixth? (20) How about the prevalence and mortality of smallpox in recent years? (21) How may the danger be measured? (22) On what day does the greatest number die? (23) What is the influence of vaccination? (24) What is the first conclusion arrived at regarding vaccination? (25) The second? (26) Third? (27) Fourth? (28) Fifth? (29) Sixth? (30) Seventh? (31) Eighth? (32) Ninth? (33) What is diphtheria? (34) How produced? (35) Describe the disease. (36) With what view have bacteriologists studied the disease? (37) Have they discovered a preventative? (38) What is it? (39) What is the first deduction of Dr. Behring in summing up the blood serum theraputic method? (40) The second? (41) Third?

(42) Fourth? (43) Fifth? (44) Sixth? (45) To what are the symptoms characterizing tetanus referable? (46) How has knowledge of the disease been increased? (47) What has been found to produce tetanus? (48) What experiments did Nicolaier make? (49) Sternberg? (50) Where is the tetanus bacillus found? (51) Does the use of tetanus antitoxin give immunity? (52) Is it also curative?

CHAPTER XXX.— (1) What does disinfection embrace in its popular sense? (2) What substances are dealt with in the process of cleansing and purifying? (3) What physical means are applied to movable matters? (4) What is done with objects which are not removable? (5) Are these methods preferable to the use of chemicals? (6) Of what are decomposition and putrefaction the result? (7) What is given off during the transmutation? (8) What do deodorants do? (9) How is preservation against decomposition practiced? (10) What kind of antiseptics should be used? (11) What does this imply? (12) What does infection in its more restricted and accurate sense imply? (13) To what is disinfection applied in recognized infectious diseases? (14) What is the only means of judging whether destruction has been effectually accomplished? (15) Thus restricted, of what does the process of disinfection admit? (16) What are some of the physical means of disinfection? (17) Which are the most efficacious? (18) What may be said of chemical agents as disinfectants? (19) On what does the efficacy of a germicide depend? (20) Give the result of Koch's experiments upon anthrax spores. (21) Why are certain of these agents ruled out? (22) What ones remain? (23) Which is the most powerful disinfectant? (24) What did Koch find? (25) What was the result of his experiments with carbolic acid? (26) How are the halogens used? (27) Give Abbott's deductions?

CHAPTER XXXI.— (1) What is the antiseptic and germicidal value of aluminum acetate? (2) Ammonium chlorid? (3) Calcium hypochlorite? (4) Cupri sulphate? (5) Ferrous sulphate? (6) Lead nitrate? (7) Manganese protochlorid? (8) Potassium arsenite? (9) Potassium bromide? (10) Potassium iodide? (11) Quinine sulphate? (12) Sodium borate? (13) Sodium carbonate? (14) Sodium hyposulphite? (15) Tin Chlorid? (16) Zinc Chlorid?

CHAPTER XXXII. — (1) What are the best agents for destroying spore containing infectious material? (2) For the destruction of micro-organisms not containing spores? (3) For excrementitious matter in sick room? (4) In privy vaults? (5) For disinfection and deodorization of surface matter in water closets? (6) For clothing, bedding, etc.? (7) For outer garments of wool or silk? (8) For mattresses, blankets, and all bedding soiled by discharge of sick? (9) For furniture, etc.? (10) For the person? (11) For the dead? (12)

For sick rooms? (13) What is a more desirable method? (14) What method for rags? (15) For disinfecting hands?

PART FIFTH—GENERAL MISCELLANY.

CHAPTER XXXIII.—(1) Define resuscitation. (2) Into what two classes divided? (3) Give treatment for syncope. (4) What is to be done if natural breathing has not returned? (5) Give position of patient. (6) Position of operator. (7) Describe action of operator. (8) What does this method do? (9) How keep up temperature of body? (10) What stimulants should be used? (11) What should be treatment for asphyxia from breathing noxious gases? (12) For asphyxia from mechanical obstructions of air passages? (13) For asphyxia from poisons and anæsthetics? (14) What serious complications result from asphyxia from immersion in water? (15) In restoring a drowned person what should be position of patient? (16) Position and action of operator? (17) What are the first steps for restoring the apparently dead from drowning, etc.? (18) What points should be aimed at? (19) How long should these methods be persevered in? (20) Is a stroke of lightning necessarily fatal? (21) What are the chances of the heart resuming its suspended action? (22) Does experience in this country justify the practice? (23) In treatment for restoring natural breathing what rule for maintaining free entrance of air into windpipe? (24) For adjusting patient's position? (25) For imitating movements of breathing? (26) For exciting inspiration? (27) In treatment after natural breathing has been restored what is the rule for inducing circulation and warmth? (28) If from intense cold? (29) If from intoxication? (30) If from apoplexy or sunstroke? (31) How soon may alcoholic stimulants be given?

CHAPTER XXXIV.—(1) What are post-mortem wounds? (2) When is the poison present in its most virulent form? (3) It is most marked when inoculation occurs from handling what kind of cases? (4) How does the poison act? (5) What serve as points of inoculation? (6) What should be done with the hands before beginning to operate on a dead body? (7) If the cuticle be denuded what should be done? (8) How is the Champion Hand Protector used? (9) How should the instruments be used? (10) If an accident should occur, what should be done? (11) If inoculation results from a wound what are the resulting conditions? (12) What should be done if these symptoms result? (13) When is the encasing of a body in bandages necessary? (14) Describe the method of bandaging in detail.